JOURNAL OF DAIRY SCIENCE

Contents

A Quantitative Spectrographic Method for the Determination of Tin, Copper, Iron, and Lead in Milk and Milk Products. The Effect of Storage on the Concentration of These Metals in Evaporated Milk. C. W. GEHRKE, C. V. RUNYON, AND E. E. PICKETT 1401

An Ion-Exchange Resin-Contact Time Method for the Study of Inorganic Equilibria in Milk. J. M. BAKER, C. W. GEHRKE, AND H. E. AFFSPRUNG 1409

Frozen Homogenized Milk. IX. Freezing Characteristics of Homogenized and Unhomogenized Milk. C. J. BABCOCK, D. R. STROBEL, LT. COL. R. H. YAGER, AND E. S. WINDHAM 1416

Body Weights, Body Measurements, and Surface Area of Jersey and Sindhi-Jersey (F_1) Crossbred Females. R. E. MCDOWELL, DOUGLAS H. K. LEE, H. W. MCMULLAN, M. H. FOHRMAN, AND W. W. SWETT 1420

A Comparison of Fertility of Bovine Spermatozoa Stored at 5° C. and −79° C. H. O. DUNN, H. D. HAFS, P. J. BUCKNER, G. F. YOUNG, E. O. CONRAD, E. L. WILLETT, AND G. L. LARSON 1429

The Relationship Between Forage Dry Matter Digestibility and Weight Gain by Dairy Heifers on Three Winter Grazing Crops. M. E. MCCULLOUGH, D. M. BAIRD, AND O. E. SELL 1435

Semen Production and Fertility of Dairy Bulls Ejaculated Either Once or Twice at Intervals of Either Four or Eight Days. R. W. BRATTON AND R. H. FOOTE 1439

Semen Production and Fertility of Mature Dairy Bulls Ejaculated Either Once or Twice at 8-Day Intervals. R. W. BRATTON, R. H. FOOTE, AND C. R. HENDERSON 1444

The Release of Ammonia Nitrogen from Urea, Ammoniated Molasses, and Soybean Oil Meal in the Presence of Rumen Microorganisms. O. T. STALLCUP 1449

Excretion of Dieldrin in the Milk of Cows Fed Dieldrin-Sprayed Forage and Technical Dieldrin. RAY E. ELY, L. A. MOORE, R. H. CARTER, P. E. HUBANKS, AND F. W. POOS 1461

In Vitro Studies of the Effect of Aureomycin and Terramycin on Mixed Suspensions of Bovine Rumen Bacteria. P. JURTSHUK, JR., R. N. DOETSCH, J. J. MCNEILL, AND J. C. SHAW 1466

Technical Notes 1473

People and Events 1475

Letters to the Editor 1482

Our Industry Today:

Laboratory Training Program of the Robert A. Taft Sanitary Engineering Center in Milk and Food Sanitation. ROBERT P. MYERS 1483

The Bulk Milk Handling and Pipe Line Milking on the Farm. H. E. CALBERT 1485

Call for Papers for Annual Meeting 1489

Author Index of Original Articles 1490

Subject Index of Original Articles 1500

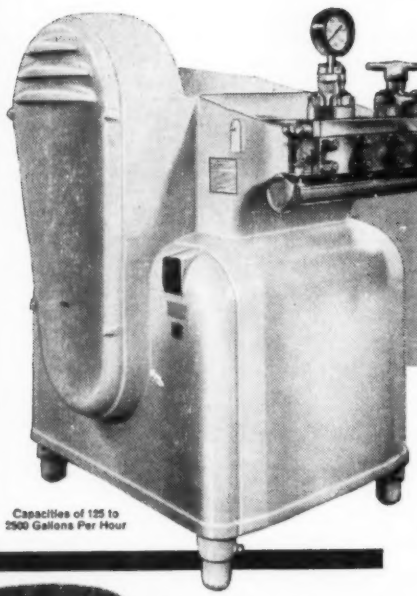
Author Index of Abstracts A157

Subject Index of Abstracts A176

Vol. XXXVII, No. 12, December, 1954

Published by the

AMERICAN DAIRY SCIENCE ASSOCIATION



Capacities of 125 to 2500 Gallons Per Hour

NEW

MULTI-FLO HOMOGENIZER

FOR MILK OR MIX

New CP Bell-Flow Single Service Valve provides effective break-up and dispersion. Insures new homogenizer performance and uniform results with every run. Replaceable in minutes for pennies. *Exclusive with CP.*

New STAINLESS CONSTRUCTION—Now—all metal in contact with product is *stainless steel.*

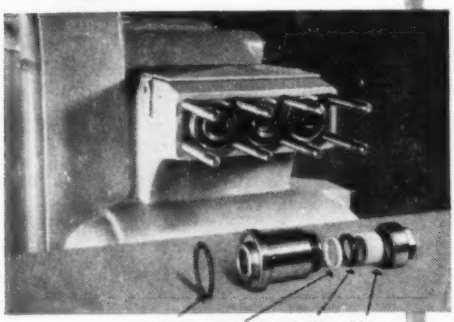
New CP head design employs only *one plunger packing ring* per cylinder. New nylon seal seat and follower reduce maintenance—give longer life at less cost.

New CP clamp-on suction type manifold with plastic seal rings assures positive sealing—saves time.

You get these new features PLUS these time-tested CP Multi-Flo benefits: . . . uniformly fine results on true low pressures with less power, less strain... Flexibility in design—that lets you increase capacity of most models very economically by adding larger components on original frames.

Enjoy the performance and economy features of the new CP Multi-Flo Homogenizer. Write for more complete details, or ask your CP representative.

NEW CP BELL-FLOW SINGLE SERVICE VALVE is shaped and designed to give effective break-up and dispersion.



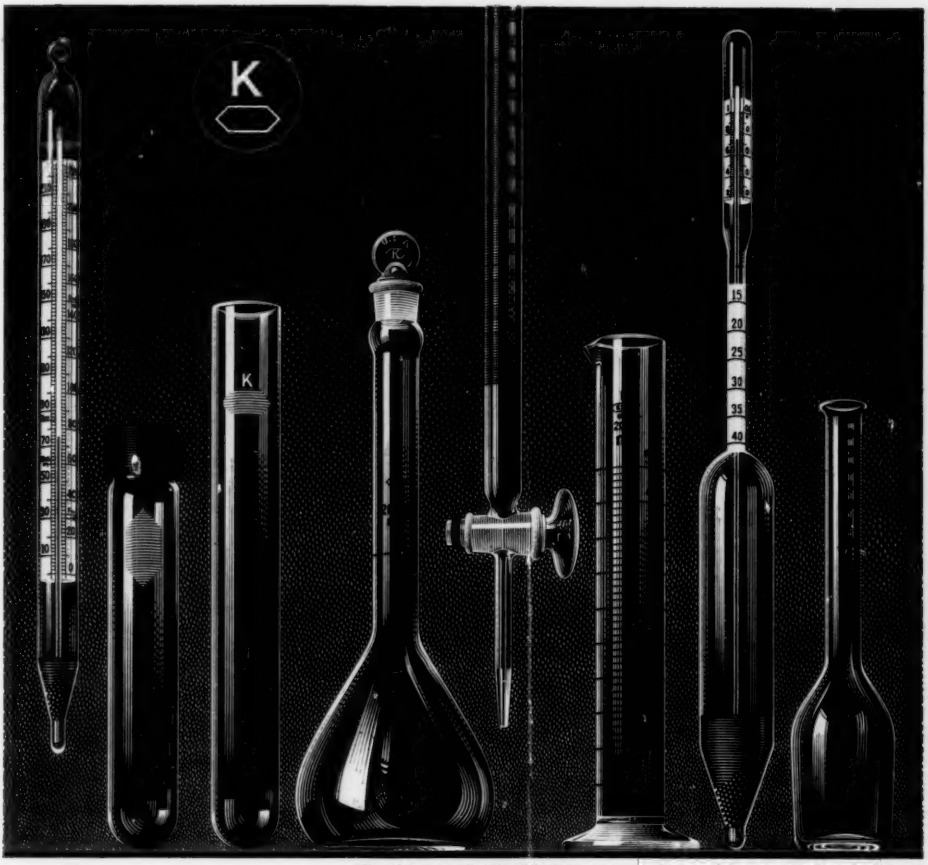
New CP head design employs just one plunger seal ring per cylinder, with nylon seal seat and follower. Less maintenance, better performance.

THE *Creamery Package* MFG. COMPANY

General and Export Offices:
1243 W. Washington Blvd., Chicago 7, Illinois

Branches: Atlanta • Boston • Buffalo • Chicago • Dallas • Denver • Houston • Kansas City, Mo. • Los Angeles • Memphis • Minneapolis • Nashville • New York • Omaha • Philadelphia • Portland, Ore. • St. Louis • Salt Lake City • San Francisco • Seattle • Toledo • Waterloo, Iowa

CREAMERY PACKAGE MFG. CO. of CANADA, LTD.
267 King St., West, Toronto 2B, Ontario
THE CREAMERY PACKAGE MFG. COMPANY, LTD.
Mill Green Road, Mitcham Junction, Surrey, Eng.



Precision-made Kimble Glassware—*standard in an exacting industry.*

ACCURATE!

KIMBLE DAIRY TEST WARE

Made to make the most rigid tests of the industry

Outstanding quality and assured accuracy have established Kimble Dairy Glassware as the recognized standard of the dairy industry—for test, analysis and control.

Kimble Dairy Glassware meets all federal and state requirements . . . passes the most rigid tests for accuracy and serviceability. It is made by skilled craftsmen who have devoted a lifetime to the creation of precision scientific instruments.

Uniform machine-made tubing, careful fabrication, correct retempering, durable fused-in calibrations and individual retesting assure long life and accuracy of Kimble ware. To be ACCURATE . . . specify KIMBLE.

Kimble Dairy Glassware is distributed by leading dairy supply houses throughout the United States and Canada.

Kimble Dairy Test Ware is manufactured by Kimble Glass Company, subsidiary of Owens-Illinois

KIMBLE DAIRY TEST WARE
AN (O) PRODUCT

OWENS-ILLINOIS
GENERAL OFFICES • TOLEDO 1, OHIO

Your advertisement is being read in every State and in 45 Foreign Countries

JOURNAL OF DAIRY SCIENCE

OFFICIAL ORGAN OF
AMERICAN DAIRY SCIENCE ASSOCIATION

Published at
119-123 WEST PARK AVENUE, CHAMPAIGN, ILLINOIS

P. H. TRACY, *Editor*
Urbana, Illinois

Editorial Board

J. O. ALMQUIST State College, Pa.	ROBERT JENNESS St. Paul, Minn.	E. E. ORMISTON Urbana, Ill.	M. L. SPECK Raleigh, N. C.
F. J. DOAN State College, Pa.	J. J. JEZESKI St. Paul, Minn.	R. L. PERRY Berkeley, Calif.	R. W. TOUCHBERRY Urbana, Ill.
R. E. ELY Washington, D. C.	J. P. MIXNER Sussex, N. J.	J. T. REID Ithaca, N. Y.	EVERT WALLENFELDT Madison, Wis.

Committee on Journal Management
J. H. ERB, *Chairman*

G. W. TRIMBERGER — P. H. TRACY (ex officio)
W. M. ROBERTS — T. D. HARMAN (ex officio)

Manuscripts for publication in the Journal should be submitted to the editor, P. H. Tracy, Department of Food Technology, University of Illinois, Urbana. See Vol. 37, January issue, page 103 for information concerning the preparation of manuscripts.

Subscriptions. Price, $10.00 per volume in North and South America; $10.50 in all other countries. Prices are net, postpaid. New subscriptions and renewals are entered to begin with the first issue of the current volume. Renewals should be made promptly to avoid a break in the series. Subscriptions should be sent to T. D. Harman, The Ohio State University, Columbus 10, Ohio.

Subscriptions for the British Isles and British Empire, except for Canada and Australia, should be ordered through our agents: Messrs. Bailliere, Tindall and Cox, 7 and 8 Henrietta Streets, Covent Garden, London, W. C. 2, England. Subscriptions for Australia should be sent to our agent: John H. Bryant, Herbert St., St. Leonards, N. S. W., Australia.

Advertising copy should be mailed to T. D. Harman, The Ohio State University, Columbus 10, Ohio. Advertising plates or cuts should be mailed direct to The Garrard Press, 119-123 West Park Ave., Champaign, Illinois.

Post office notices of undeliverable copies and changes of address should be sent to T. D. Harman at the address above stated.

OFFICERS OF THE ASSOCIATION

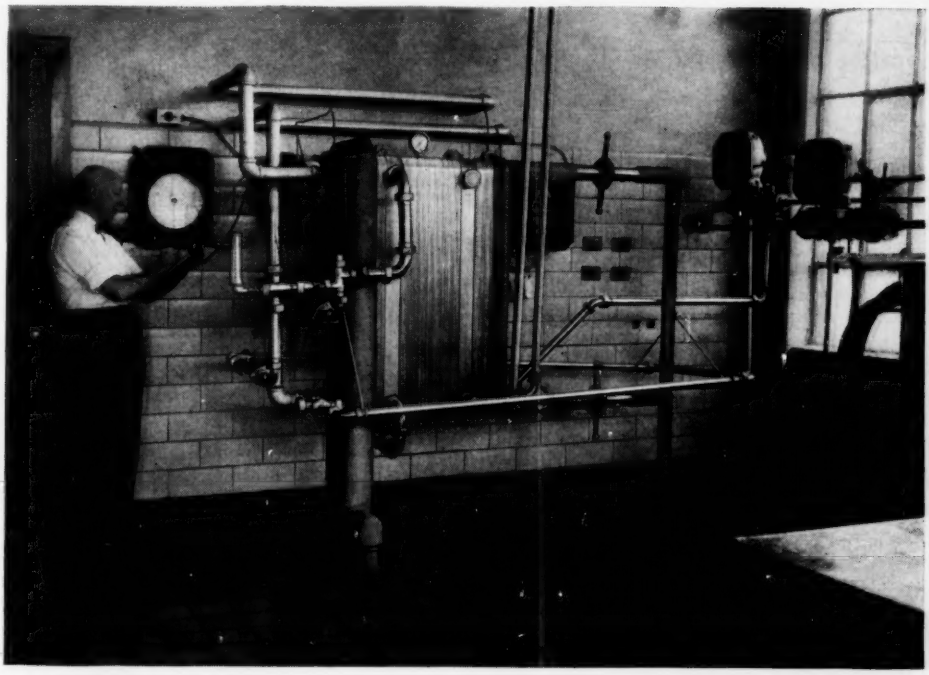
L. A. MOORE, *President*, Beltsville, Md. — T. D. HARMAN, *Sec.-Treas.*, Columbus, Ohio
I. A. GOULD, *Vice-President*, Columbus, Ohio — P. H. TRACY, *Journal Editor*, Urbana, Illinois

DIRECTORS

N. N. ALLEN Madison, Wis.	R. E. HODGSON Beltsville, Md.	GEORGE HYATT, JR. Raleigh, N. C.	D. V. JOSEPHSON State College, Pa.
W. V. PRICE Madison, Wis.	L. H. RICH Logan, Utah	G. W. SALISBURY Urbana, Ill.	

Entered as second-class matter at the post office at Champaign, Illinois, under the act of March 3, 1879.

Your advertisement is being read in every State and in 45 Foreign Countries

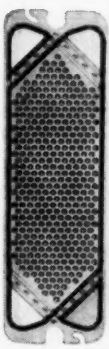


He's keeping tabs . . . on what?

This operator is taking a reading on "Superplate"—Cherry-Burrell's flexible plate-type heat exchanger. But what's he keeping tabs on? What's the process? And what's the product?

You can't tell—from the picture. That's because Cherry-Burrell's versatile "Superplate" operates on many milk and food products with equal facility—as a heater, cooler, regenerator or Shortime pasteurizer. There's virtually no limit to the liquid . . . or process . . . "Superplate" can handle.

But regardless of how you use "Superplate" you can be sure it will speed processing operations, lower refrigeration, water and steam costs, help produce a better and more sanitary product.



ELECTROPOLISHED KNOB-TYPE PLATES ASSURE BETTER HEAT TRANSFER

Exclusive Electropolished Plates give greater resistance to water deposits; eliminate sticking of solids.

3-D Turbulence set up by patented knobbed design accelerates heat transfer with low pressure drop.

Non-Clogging Flow Space between plates, full length.

Largest Port Areas of any plate for low product and coolant pressures.

For all the facts about "Superplate", contact your nearby Cherry-Burrell Representative. Or write for literature.

CHERRY-BURRELL CORPORATION

427 W. Randolph Street, Chicago 6, Ill.

Equipment and Supplies for Industrial and Food Processing

FACTORIES, WAREHOUSES, BRANCHES, OFFICES OR DISTRIBUTORS AT YOUR SERVICE IN 56 CITIES

Your advertisement is being read in every State and in 45 Foreign Countries

yes, there is a difference in

FILTER DISKS

Of course there's a difference in filter disks. Chances are it's not the difference you may *see* . . . like the thickness or the surface of the disk or even the color of the box.

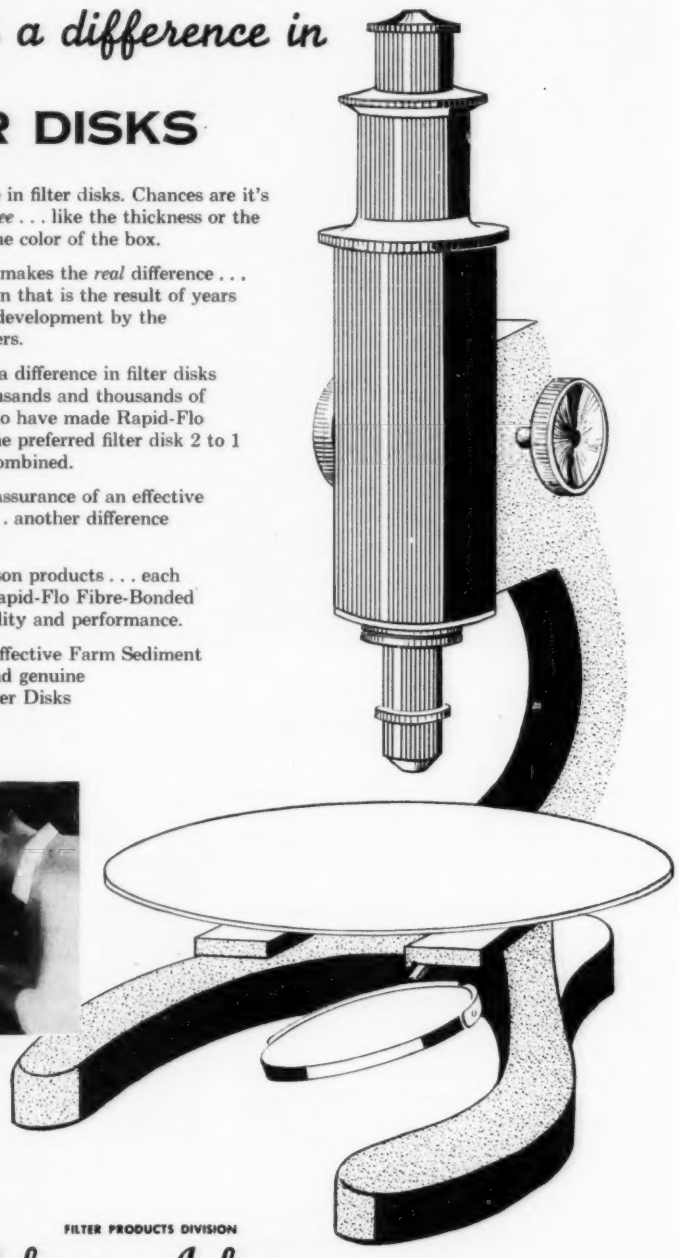
It's what you don't see that makes the *real* difference . . . the assurance of safe filtration that is the result of years of painstaking research and development by the Johnson & Johnson researchers.

The final proof that there is a difference in filter disks is found on the farms of thousands and thousands of quality-minded dairymen who have made Rapid-Flo Fibre-Bonded Filter Disks the preferred filter disk 2 to 1 over the next three brands combined.

And Rapid-Flo safety gives assurance of an effective Farm Sediment Check-Up . . . another difference that you don't see.

Yes, like all Johnson & Johnson products . . . each outstanding in its field . . . Rapid-Flo Fibre-Bonded Filter Disks give proved quality and performance.

For safe milk filtration and effective Farm Sediment Check-Ups always recommend genuine Fibre-Bonded Rapid-Flo Filter Disks



FILTER PRODUCTS DIVISION

Johnson & Johnson

4949 WEST 65th STREET CHICAGO 38, ILLINOIS

Your advertisement is being read in every State and in 45 Foreign Countries

JOURNAL OF DAIRY SCIENCE

VOLUME XXXVII December, 1954 NUMBER 12

A QUANTITATIVE SPECTROGRAPHIC METHOD FOR THE DETERMINATION OF TIN, COPPER, IRON, AND LEAD IN MILK AND MILK PRODUCTS. THE EFFECT OF STORAGE ON THE CONCENTRATION OF THESE METALS IN EVAPORATED MILK[1]

C. W. GEHRKE, C. V. RUNYON, AND E. E. PICKETT

Department of Agricultural Chemistry
Missouri Agricultural Experiment Station, Columbia

Some of the deteriorative changes which are manifested in evaporated milk during storage at various temperatures have been extensively investigated. These are: the increase in concentration of lactic and formic acids *(11)*; the changes in pH, viscosity, fat and protein separation, and development of crystals of calcium citrate *(21, 22)*; browning, fluorescence, and associated changes *(16, 17)*; and gel formation and fat separation *(18)*.

There have been few published data *(7, 14, 19)* concerning the increase in concentration of metals in canned milks with increasing storage time at various temperatures, and the relationships that exist between changes in the concentration of these metals and deteriorative changes *(11, 16, 17, 18, 21, 22)* which occur in the milk during storage are little known. Perhaps some of the changes in the physicochemical properties of stored evaporated milk may be due to the presence of various metallic contaminants. Recent studies *(1)*, conducted with ion-exchange resin membrane electrodes, of the interaction of calcium chloride, calcium mono and dihydrogen citrate, and calcium dihydrogen phosphate with casein sols show that no chemical reaction occurs between the calcium ion and casein. The casein simply behaves as a hydrophobic colloid. The same observation was noted in other experiments *(8)* on the addition to evaporated milk of stannous chloride at various concentrations. In the past, one of the authors *(14)* has done a substantial amount of work on analytical methods for, and the determination of, the concentration of metals in evaporated milk held under different storage conditions, and it is known that the average can of evaporated milk contains significant quantities of tin. It is also possible that considerable amounts of iron, lead, and copper could be in the milk. Many chemical methods are used for the determination of tin *(10, 15)*, copper *(12, 20)*, iron *(3, 13)*, and lead *(2)* in foods and food products. These methods leave much to be desired, especially for tin, copper, and lead. In general, they are long and difficult and

Received for publication September 10, 1953.

[1] Journal Series Paper No. 1458 approved by the director of the Missouri Agricultural Experiment Station.

involve several chemical separations. Most of the spectrographic methods are qualitative and involve only the trace element content *(5, 6)*.

The major objectives of this investigation were to develop a rapid, simple, and accurate spectrographic method for the quantitative determination of tin, copper, iron, and lead, all at the same time, in milk and evaporated milk and to follow the increase in metallic concentration in evaporated milk under different storage conditions.

EXPERIMENTAL PROCEDURE

Preparation of standards and spectrographic method. In preparing the standard samples it was necessary to determine the temperature to be used in the ashing of the whole milk. Several samples of milk were ashed at various temperatures in order to determine the minimum temperature required to obtain a dry, loose ash. It was found that not all of the organic matter needed to be destroyed. The whole milk samples were satisfactorily ashed at 400° C. over night in a Cenco Cooley electric furnace. It is necessary to conduct the ashing at a low temperature to prevent volatilization of tin. Prior to ashing, the milk was evaporated to dryness at 80° C. in a forced draft drying oven. This was necessary to avoid foaming of the milk and consequent loss of the sample during ashing.

Whole milk ash was used in preparing the matrix of the spectrographic standards. All precautions were observed to prevent contamination of the milk. A quart of whole milk, obtained from the Department of Dairy Husbandry, University of Missouri, was taken directly from the cow into a thoroughly cleaned Erlenmeyer flask. The flask was cleaned several times with double distilled hydrochloric acid and double distilled water. The milk was evaporated to dryness at 80° C. and ashed at 400° C. in a vitreosil evaporating dish.

The following chemicals and substances were used in preparing the spectrographic standards: *(a)* the metallic oxides (CuO, Fe_2O_3, PbO, and SnO_2), *(b)* a buffer mixture containing 50% of $CaCO_3$ and 50% of KCl, *(c)* milk ash as previously described, *(d)* internal standards of CdO and NiO and, *(e)* spectrographically pure graphite.

All of the chemicals used were reagent grade and repurified with the exception of the cadmium oxide and nickel oxide, which were of "spectrographic standardized" grade as received from Johnson, Matthey and Company, London, England.

Tin, copper, iron, and lead were added in equivalent amounts, as oxides, to prepare standards containing the following percentages of each metal: 1.00, 0.316, 0.100, 0.0316, 0.0100, 0.00316, 0.00100, 0.000316, and 0.000100. The total weight of each standard was 1 gram. Of this 1 gram, the remaining weight not occupied by the metal oxides consisted of 50% milk ash and 50% buffer mixture. The concentrated standards were used to prepare the less concentrated ones; in this way, all weighings were made on a regular analytical balance. After the above standards were prepared, they were mixed thoroughly in an agate mortar. To prepare the arcing mixture 10 mg. of CdO and 10 mg. of NiO (internal

standards) and 200 mg. of spectrographically pure graphite were added to 80 mg. of each of these prepared standards of tin, copper, iron, and lead. These preparations were again thoroughly mixed in an agate mortar. The purpose of the graphite was to ensure a more nearly complete volatilization of the samples by preventing the formation of a bead of refractory calcium oxide at the high temperature of the arc. It was found that this bead would prevent complete volatilization of the iron during arcing.

A Jarrell-Ash 480-cm. adjustable stigmatic grating spectrograph was used in this investigation. The source of power was 220 volts a.c., 3-phase, rectified to 280 volts d.c. The operating voltage at the arc was 50, and the current was 7 amperes.

Each standard or sample was filled into the crater of a 3/16 in. high purity carbon electrode. Each electrode was pre-arced for 30 seconds just before the addition of the sample. Normal polarity was used for the electrodes with no lens between the arc and the slit. The slit width was set at 50μ and the slit length at 6 mm. A three-step sector was used to obtain a wide range of intensities, permitting 100%, 10%, and 1% of the incident light to pass through the slit. The standards and samples were exposed for 1 minute. The region of the spectrum from 2400 to 4100 angstroms was photographed. Spectrum Analysis No. I film (35 mm. wide) was used and was developed for 4 minutes in D-19, fixed 5 minutes in F-5, washed 5 minutes in water, and then dried. The per cent transmission of the lines was measured with a Jarrell-Ash Projection-Comparator Microphotometer. These per cent transmissions were translated into intensities by means of film calibration curves prepared for the regions 2800 and 3200 angstroms. The analytical lines used were 2840 and 3330.6 Å for tin, 2833.1 Å for lead, 3247.5 Å for copper, and 3020.6 Å for iron. For analyses on tin, lead, and copper the cadmium line at 3261.1 Å was used as the standard, and for iron the nickel line at 3064.6 Å was the standard.

The ratios of the intensities of the lines of the desired elements to those of the lines of the internal standard elements described above were plotted as ordinate versus concentration on linear coordinate paper. After a straight line was drawn through the points, a line parallel to this plotted line was drawn so as to intersect the origin. The "residual" metal concentration in the standard matrix was determined by drawing a line parallel to the abscissa from the intercept of the plotted line until it intersected the second parallel line. The concentration of metal corresponding to this point of intersection was the concentration of the metal in the matrix of the standards, the "residual" concentration.

A working curve for each metal was made by plotting on log-log paper the intensity ratios vs. the concentration (added plus residual) of the metal in parts per million in the 80 mg. of standard. Straight line working curves were obtained, the slopes of which approached the theoretical of 45°. When it was found that the concentration of tin in evaporated milk was much higher than that of the other metals, an additional curve for tin was drawn covering the high concentrations. For this curve the ratios of the intensities of Sn 3330.6 angstroms to those of Cd 3261.1 angstroms were plotted versus concentration of tin in parts per million.

Preparation and arcing of samples. The experimental samples of evaporated milk were placed in the vitreosil crucibles immediately after opening the cans. This was necessary, as it has been shown previously that a significant increase occurs in the content of iron *(4)* in evaporated milk and tin *(9)* in canned fish exposed to air in open cans.

A known weight of the evaporated milk (approximately 5 g.) was placed in a weighed vitreosil crucible, dried at 80° C., and ashed at 400° C. over night in an electric furnace. After obtaining the weight of the ash, 40 mg. of the thoroughly mixed milk ash and 260 mg. of a mixture containing 200 mg. of graphite, 10 mg. of CdO, 10 mg. of NiO, 20 mg. of KCl, and 20 mg. of $CaCO_3$ were placed in a clean agate mortar and thoroughly mixed. The spectrographic method used for arcing the samples of evaporated milk was the same as that described for the prepared standards. After determining the intensity ratios, the corresponding concentrations of the metals in parts per million were read from the working curves. Blanks were analyzed which contained all of the substances used in the preparation of the samples. The concentrations of metals in these blanks were subtracted from the total concentration.

The values obtained from the working curves were doubled to give the concentration in parts per million of the metals in the evaporated milk ash because only 40 mg. of milk ash were used in the arcing mixture, whereas 80 mg. of the standards were used in preparing the working curves. These values represent the concentrations of the metals in the original evaporated milk ash. The concentration in parts per million of the metals in the evaporated milk was calculated.

Description of the evaporated milk and storage treatment. Five cases of evaporated milk in electrolytically plated cans and four cases of milk in hot-dipped cans were numbered and stored at room temperature and at 37° C. for time periods up to 1 year. Each case contained 48 (13-fl. oz.) cans. The electrolytic cans contained 0.75 lb. of tin per base box, and the hot-dipped cans were plated with 1.25 lb. of tin per base box. Both the electrolytic and the hot-dipped type of plates were made by the Weirton Steel Company, Weirton, West Virginia. The can bodies were made the same day the milk was packed. All of the evaporated milk used in the storage studies was from mixed herd milk and was packed at the same time during the normal operation of a large commercial evaporating plant. Standard procedures were used in processing the milk. The equipment used was stainless steel with the exception of the cooling coils, which were tin-coated copper, and the fillers, which were brass.

Prior to storage, each can of evaporated milk was examined for damage, and notations were made. Examinations of the cans were made periodically for flipper formation and swells. "Flipper" is a term used to denote formation of gases inside the can, resulting in loss of vacuum. Such a condition permits the end of the can to snap in and out when pressure is applied at both ends of the can. A "swell" occurs when the can passes the flipper stage and the gas pressure on the inside causes the ends to bulge. With each examination, about once a

week, all of the cans were turned and several flat cans and all the flippers were removed.

In addition to analyzing the samples of stored evaporated milk for tin, iron, copper, and lead, the following observations were made: When the cans were opened the pH of the milk was determined, a visual examination was made for salt precipitation and fat separation, and the inside of the can was examined for corrosion.

RESULTS AND DISCUSSION

Flippers occurred in both the electrolytic and hot-dipped types of tin-plated cans when stored at 37° C. but were more pronounced in the electrolytic cans. The maximum life of the electrolytic cans at 37° C. was 180 days and that of the hot-dipped cans was about 300 days. There was no significant difference in the pH decrease of the evaporated milk after various storage periods in the two types of tin-plated cans (6.20 to 5.55 after 318 days at 37° C.); the appearance of the milk in the normal cans and in flipper cans plated with either type of tin plate and stored at 37° C. and room temperature was similar. However, darkening and fat separation of the milk were evident in both types of cans after 81 days at 37° C.

A comparison of the corrosion occurring on the inside of the electrolytic and hot-dipped cans was difficult to make. "Pitting," a term used to denote fine, pinpoint holes through the tin coating, appeared in both types of cans along with sulfur staining, which is a discoloration of the tin coating due to reaction with the sulfur compounds in the evaporated milk. Long, vertical body maker scratches occurred in both types of cans but were more noticeable in the electrolytic cans. Definite corrosion occurred in all cans stored at 37° C., and after 318 days of storage all the tin was gone and only the tin-iron alloy layer remained. The cans stored at room temperature were detinned more slowly and showed some darkening of the can walls, but many of the cans still had some tin remaining after 318 days.

TABLE 1

Concentration of tin in evaporated milk

Storage time	Storage temperature	Concentration of tin in p.p.m.[a]	
		Electrolytic cans	Hot dipped cans
(days)			
as rec'd	37° C.	22.3	19.1
12	37° C.	28.8	32.2
26	37° C.	55.0	39.9
38	37° C.	66.9	39.5
50	37° C.	97.4	78.5
340	37° C.	215	209
as rec'd	room temp.	22.3	19.1
26	room temp.	30.1	39.5
38	room temp.	28.3	56.3
50	room temp.	45.1	50.8
340	room temp.	102	125

[a] Average of at least two independent determinations.

The concentration of tin in the evaporated milk stored in either electrolytic or hot-dipped cans increased with storage time and higher temperature. The average concentration of tin in the evaporated milk as received in the electrolytic and hot-dipped cans was 22.3 and 19.1 p.p.m., respectively. After 50 days of storage at 37° C., the average concentration of tin was 97.4 p.p.m. in electrolytic cans and 78.5 p.p.m. in hot-dipped cans; after a holding period of 340 days, the concentrations increased to 215 and 209 p.p.m., respectively. About one-half as much tin was found in the evaporated milk in electolytic cans when stored at room temperature for different periods as in that held at 37° C.; this was also found for the milk in the hot-dipped cans after long storage. The experimental data are presented in Table 1.

It was considered possible that some of the tin content of the evaporated milk could have been lost by volatilization during the ashing process. Recovery experiments were conducted with several samples of raw whole milk which contained known amounts of added tin. The data are shown in Table 2. From these

TABLE 2
Recovery of tin added to whole milk

p.p.m. of tin[a]	
Added	Recovered
120.9	122.1
46.5	43.6
46.0	45.0
14.2	12.8
0.3	0.4
0.1	0.2

[a] Average of at least two independent runs.

data it may be concluded that no tin was lost during the ashing of the samples. The recovery of tin was considered good, and the data indicate that the method is accurate for tin. In this investigation, recovery studies for Fe, Cu, and Pb were not made. Other spectrographic data obtained at the Missouri Agricultural Experiment Station on plant and animal materials show that no losses occurred and recoveries were as good as those given for tin.

The average content of iron for 22 cans of evaporated milk representing both plate types and storage temperatures and held 0-50 days was 6.5 p.p.m. (ranging between 1.3 and 14.2), and 16.5 p.p.m. (ranging between 4.0 and 36.2) for 12 cans stored 340 days. The observed variation in iron content from can to can and for different storage conditions was presumably due to differences in the extent of corrosion.

The concentration of copper and lead in the evaporated milk did not change appreciably with storage. The mean values for 35 different cans were 0.68 p.p.m. for copper and 0.35 p.p.m. for lead. The values ranged from 0.46 to 1.04 p.p.m. for copper and from 0.09 to 0.72 for lead.

The principal causes of inaccuracy in spectrographic methods are the so-called "extraneous element effect" and the usual deviations of replicate results. The latter are measured by the precision or reproducibility of the results which have

been determined for various samples. The reproducibility of results for the respective elements (Sn, Fe, Cu, and Pb) ranged from ±5 to ±8% of the values. The "extraneous element effect," that is, the influence of the major constituents upon the line intensities of the minor elements, has been corrected for by the addition of as much milk ash to the standards as was contained in the sample mixtures. The rather small variation in amounts of the major elements in milk should not influence the magnitude of the "extraneous element effect" from one sample to another. Moreover, the variations in amounts of the principal major elements are made very small by addition of the KCl and $CaCO_3$ buffer mixture to the standards and samples.

SUMMARY

A rapid, reliable, and accurate spectrographic method has been developed for the quantitative determination of tin, copper, iron, and lead in milk and evaporated milk. The analyses for these metals can be made simultaneously on a single sample. The precision of the method for the respective elements is from ±5 to ±8%.

Graphite was added to the arcing mixture. This was to ensure a more nearly complete volatilization of the samples and to prevent the formation of a refractory calcium oxide bead.

The concentration of tin in evaporated milk was found to increase rapidly when stored at either 37° C. or room temperature. This was found to be true for milk stored in either the electrolytic or hot-dipped plated cans. The average concentration of tin in evaporated milk as received was about 20 p.p.m.; after 50 days of storage at 37° C. in electrolytic cans the tin concentration increased to 97.4 p.p.m., and after 340 days to 215 p.p.m. The rate of solution of tin was faster in the electrolytic cans than in the hot-dipped cans when stored at 37° C. At room temperature storage the concentration increased at about the same rate in both types of plated cans.

The iron content of evaporated milk increased with storage from 6.5 p.p.m. (0-50 days) to 16.5 p.p.m. (340 days) as an average for 22 and 12 cans, respectively.

No significant increase was found in the concentration of copper or lead when the evaporated milk was stored in either type of can at room temperature or 37° C. for as long as 340 days. The mean values were 0.68 p.p.m. for copper and 0.35 p.p.m. for lead as an average for 35 cans.

The rate of change of pH was faster in milk in cans stored at 37° C. than in those stored at room temperature. A decrease in pH, from 6.20 to 5.55, occurred within a period of 300 days. Flippers developed more rapidly in the electrolytic cans. Darkening occurred and fat separation was evident in both types of cans after 81 days of storage at 37° C. Corrosion occurred in all cans stored at 37° C., and after about 300 days of storage all of the tin coating was gone and only the tin-iron alloy layer remained.

ACKNOWLEDGMENT

The authors wish to express their thanks to the Evaporated Milk Association for its support and cooperation in this investigation.

REFERENCES

(1) Affsprung, H. E., and Gehrke, C. W. The Activity of Calcium Chloride, Calcium Mono and Dihydrogen Citrate and Calcium Dihydrogen Phosphate in Casein Sols. Unpublished Manuscript. 1954.

(2) Allport, N. L., and Skrimshire, G. H. A New Method for the Determination of Lead in Organic Material with Special Reference to Dyestuff. *Analyst*, **57**: 440. 1932.

(3) Bandemer, S. L., and Schaible, P. J. Determination of Iron. *Ind. Eng. Chem., Anal. ed.* **16**: 317. 1944.

(4) Cole, W. C., and Tarassuk, N. P. Evaporated Milk as Related to Greenish Discoloration in Coffee. *J. Dairy Sci.*, **28**: 57. 1945.

(5) Dingle, H., and Sheldon, J. H. Spectrographic Examination of the Content of the Human and Other Milk. *Biochem. J.*, **32**: 1078. 1938.

(6) Drea, W. F. Spectrum Analysis for Trace Elements in Ashes of Human, Goat, and Cow Milk. *J. Nutrition*, **16**: 325. 1938.

(7) Fairhall, L. T. The Lead Content of Evaporated Milk. *J. Ind. Hyg. and Toxicol.*, **19**: 491. 1937.

(8) Gehrke, C. W. The Ionic Concentration of Milk as Related to Protein Stability. *Termination Report*. Quartermaster Food and Container Institute for the Armed Forces, Chicago. 1954.

(9) Glassman, B., and Barsutzkaja, S. Volumetric Method for the Determination of Tin in Preserves and Other Foodstuffs. *Z. Untersuch. Lebensm.*, **56**: 208. 1928. *Analyst*, **54**: 110. 1929.

(10) Godar, E. M., and Alexander, O. R. (American Can Company, Maywood, Ill.) Polarographic Determination of Tin in Foods and Biological Materials. *Ind. Eng. Chem., Anal. ed.* **18**: 681. 1946.

(11) Gould, I. A., Weaver, E., and Frantz, R. S. Lactic Acid in Dairy Products. *J. Dairy Sci.*, **29**: 33. 1946.

(12) Krenn, J. Report on Copper. *J. Assoc. Offic. Agr. Chemists*, **13**: 426. 1930.

(13) Ruegamer, W. R., Michaud, L., and Elvehjem, C. A. A Simplified Method for the Determination of Iron in Milk. *J. Biol. Chem.*, **158**: 573. 1945.

(14) Runyon, C. V. The Concentration of Metals in Evaporated Milk Stored Under Various Conditions. Unpublished Research. 1950.

(15) Scott, W. W. *Standard Methods of Chemical Analysis*. D. Van Nostrand Co., Inc., New York, Toronto, London, Vol. I, 5th ed. 1939.

(16) Simonson, H. D., and Tarassuk, N. P. Fluorescence and Associated Changes Produced Upon Storage of Evaporated Milk. *J. Dairy Sci.*, **35**: 166. 1952.

(17) Tarassuk, N. P., and Simonson, H. D. Browning and the Fluorescence of Evaporated Milk. *Food Technol.*, **4**: 88. 1950.

(18) Tarassuk, N. P., and Simonson, H. D. Gel Formation and Fat Separation in Evaporated Milk as Affected by the State of Milk Proteins. *J. Dairy Sci.*, **34**: 482. 1951.

(19) U. S. Food and Drug Administration Release, *Contamination of Foods with Arsenic and Lead*. Dec. 14, 1935.

(20) Walker, R. Report on Copper. *J. Assoc. Offic. Agr. Chemists*, **13**: 426. 1930.

(21) Webb, B. H., and Deysher, E. F. Effect of Storage Temperature on the Properties of Evaporated Milk. USDA, *BDI-Inf*-122. June, 1951.

(22) Webb, B. H., Deysher, E. F., Hufnagel, C. F., and Potter, F. E. Separation of Fat and Protein in Sterilized Milks During Storage. USDA, *BDIM-Inf*-100. June, 1950.

AN ION-EXCHANGE RESIN-CONTACT TIME METHOD FOR THE STUDY OF INORGANIC EQUILIBRIA IN MILK[1,2]

J. M. BAKER, C. W. GEHRKE, AND H. E. AFFSPRUNG
Department of Agricultural Chemistry, University of Missouri, Columbia

The stability of the milk proteins as influenced by the cation-anion balance of the milk has been a subject of much consideration by investigators in the fields of dairy chemistry and technology. As a consequence, a number of different experimental approaches have been used in an attempt to clarify the chemistry of, and the phasic distribution of, the inorganic components of milk. Seekles and Smeets *(12, 13)* conducted an extensive study on heat-stable and unstable milks in the Netherlands. A correlation was made between the calcium and phosphorus content of the milk ultrafiltrates and the heat stability of the milk proteins as measured by the alcohol test. Ultrafiltration studies were conducted by Jenness *(7)* on milks subjected to heat treatments in the temperature range of 67-98° C. The ultrafilterable calcium and phosphorus were found to decrease immediately after heating but again to approach the normal values in the aged heated milk.

Other investigators used collodion membranes and dialysis experiments *(6, 8, 10, 11)* in studies on the colloidal and soluble phases of the inorganic constituents of heated and raw milks. In nearly all cases long time intervals were involved. Zeolite type ion exchangers were employed by Davies *(2)* to study the phase distribution of calcium in reconstituted milks. The batch process was used and involved contact time periods from 10 minutes to 48 hours. Verma *(15)* conducted a study on the colloidal and soluble polyvalent inorganic constituents in raw and heated skimmilks by removing the protein with rennet precipitation.

The more recent work cited in the references has been conducted on ultrafiltrates and whey prepared from samples of raw and heat-treated skimmilks by rennet action. The process of obtaining an ultrafiltrate requires a length of time varying from 30 minutes to several hours, during which time many changes may take place in the chemical equilibria of the milk. The colloidal systems that occur in milk and which may be altered during heating are also subject to the limitations of the restrictions of the membrane. The production of whey by rennet action involves the precipitation of the protein, which is capable of carrying down portions of the inorganic colloidal particles of the milk. These procedures leave much to be desired, for many changes may occur in the distribution of the inorganic constituents during dialysis, ultrafiltration, rennet precipitation,

Received for publication October 14, 1953.

[1] Journal Series Paper No. 1437, approved by the Director of the Missouri Agricultural Experiment Station.

[2] This paper reports research sponsored by the Quartermaster Food and Container Institute for the Armed Forces and has been assigned No. 449 in the series of papers approved for publication. The views or conclusions contained in this report are those of the author. They are not to be construed as necessarily reflecting the views or indorsement of the Department of Defense.

and zeolitic contact. However, these methods were the best available, and many valuable data have been obtained.

In earlier experiments, Gehrke and Almy *(4, 5)* investigated the adsorption affinity to synthetic ion exchange resins of the cations and anions normal to milk. Single, binary, ternary, and quaternary systems were used of a concentration similar to that of milk. In view of these results, it was considered that an ion-exchange resin equilibration technique would be an approach of considerable merit. The use of an ion-exchange resin in the manner described below is chemically similar to the addition of a precipitating or complexing agent or similar chemical reagent. The reagent may also be recovered for study after definite time intervals, which in turn allows rate studies to be made.

Thus, the major objectives of this investigation were to develop a valid method for observing and following inorganic equilibria changes in milk and other complex biological systems as a result of various processing conditions and to make the measurements in a very short time period on the original sample.

EXPERIMENTAL PROCEDURE

Ion-exchange resin-contact time method (RCTM). Regenerate the ion-exchange resin in the desired form by the batch or column procedure. Wash the resin free of regenerant in a column. Remove the resin from the column and transfer the desired amount of resin ($\pm$1.0 ml. for 30 ml. or larger quantities of resin) to a 50-ml. coarse porosity fritted glass crucible. Wash the resin in the crucible thoroughly with distilled water. Transfer the resin to a 100-ml. beaker. Draw a 25-ml. aliquot of the sample test solution and place in a container from which it may be quickly poured. Then pour the sample onto the resin in the 100-ml. beaker and stir vigorously for the desired contact time. At the completion of the contact time, transfer the resin and sample to the original fritted glass crucible, which is under vacuum. Immediately wash the resin free of the sample solution with distilled water. Collect the original effluent and washings in a volumetric flask for analysis. Elute the exchanged ions from the resin with a 5% solution of the desired elutriant, using four 25-ml. portions. Allow enough time for complete elution. Wash the resin free of elutriant with distilled water. Collect the elutriant and washings and make to volume with distilled water in another volumetric flask. Take aliquots of the collections of the original effluent, and the eluate for analysis of the desired constituents.

This procedure is applicable to either the determination of anions or cations as desired. One of the major problems to be considered in the application of this technique is the choice of the proper ion-exchange resin. The resin selected for use in the preliminary investigations on the removal of calcium was made in consideration of the following points:

(a) The ability of the resin to remove Ca^{++} ions in preference to Mg^{++}, K^{+}, and Na^{+} ions, which are the other major cation constituents of milk.

(b) The ease with which the Ca^{++} ions can be eluted from the resin by elutriants which will not interfere with subsequent analysis.

(c) The ability of the resin to be placed in the regenerated condition by a

buffer system so that the milk or biological system will not be affected by a change of acidity when in contact with the resin during the removal of the various cations.

(d) A resin with a large milliequivalent exchange capacity.

The resin Amberlite IRC-50 met most of the above requirements for resin-contact time studies on removal of calcium. The resin was regenerated as completely as possible to the potassium form with a 5% potassium hydroxide solution and buffered to a pH of 6.70 by a buffer mixture containing 1.5 g. potassium hydroxide and 6.8 g. of potassium dihydrogen phosphate per liter. Calcium and magnesium are the only major cationic constituents in milk which will exchange the potassium from the IRC-50-K resin. Percentagewise, the concentration of magnesium in milk is approximately one-tenth that of the calcium. In consideration of the differences in concentration and adsorption affinities *(4, 5)* any change in the uptake of calcium would reflect real differences in the phasic distribution of the calcium in the sample. All of the experiments were conducted in the temperature range of 20 to 24° C.

Thirty ml. of the resin is recommended for each analysis, which has approximately 210 meq. of exchange capacity. The ratio of milliequivalents exchange capacity of resin to milliequivalents of calcium present in a 25-ml. sample of milk is then about 140:1. Five per cent hydrochloric acid was used as the elutriant. Calcium was analyzed by a modification developed in this laboratory of the dihydrogen disodium ethylenediamine tetraacetate method *(3)*.

The anion exchange resin, Amberlite IR-4B, was chosen for the study on the removal of phosphate from raw skimmilk. This resin met most of the requirements for the removal of anions which are similar to those stipulated above in the equilibration studies for exchange of calcium. The resin was regenerated with 5% sodium hydroxide. The resin was placed in the chloride form with 5% hydrochloric acid. Thirty ml. of resin were used, which contained approximately 60 meq. of exchange capacity. The ratio of milliequivalent exchange capacity of resin to the average milliequivalents of trivalent phosphate present in 25 ml. of raw skimmilk is about 27:1. A 5% ammonium hydroxide solution was used as the elutriant. Phosphorus was analyzed by the A.O.A.C. volumetric titration procedure *(1)*.

RESULTS AND DISCUSSION

Figure 1 presents the results of three independent determinations by the resin-contact time method for the removal of calcium from raw skimmilk. The stability numbers were measured by the acid-heat test *(14)*, somewhat modified, and were found to be seven or eight, which is the normal range for stable milk. The removal of calcium from a true solution is also plotted on the same figure. The initial level of removal of calcium from milk at the 10-second resin-contact time was found to be 36%. A rapid and constant rate of removal was then observed up to the 70% level. From the 70% level to total removal, the rate of removal becomes smaller the longer the resin-contact time interval. The pH of the contacted samples for the complete resin-contact time range varied by ±0.2 pH units from that of the original milk samples.

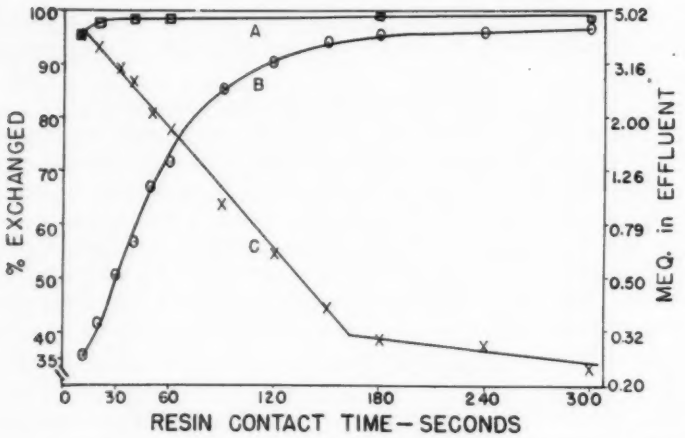


FIG. 1. The exchange of calcium ions from raw skimmilk by Amberlite IRC-50-K. Resin-contact time studies.

Curve A—% of total calcium exchanged from a true solution of $CaCl_2$.

Curve B—% of total calcium exchanged from skimmilk.

Curve C—Semi-logarithmic plot of the milliequivalents of calcium remaining in the original effluent per 100 ml. of sample vs. time.

Note: These data were obtained with 20 ml. of resin, exchange capacity—140 meq. Sample volume 25 ml.

A 36% removal for the 10-second time interval is comparable to the amount of soluble calcium found in rennet whey as reported by Verma *(15)*. A definite change in the slope of the curve occurs between the 60- and 180-second contact time. The ionic calcium and the calcium in the form of dissolved complexes are probably totally exchanged previous to the 180 seconds contact time.

It has been shown by the column technique that 99.6% of the calcium in milk is available to the resin Amberlite IRC-50-K form. This supports the view that the removal of calcium approaches 100% asymptotically. At contact times of 3 minutes or greater the curve is nearly linear, and the exchange resin is removing 95% plus of the calcium in untreated milk. When a 3-minute contact time is used in comparative studies conducted on milks subjected to various heat treatment, major changes in the chemical composition of the milk may be expressed as a function of the time and the temperature of heating. Small errors in the time of contact would not cause any appreciable changes in the results of comparative studies.

A study was made to determine the reproducibility of the RCTM. This work was conducted on a single sample of milk. An average standard deviation of ± 0.38 mg. was obtained from the results on three replicate analyses on 25-ml. samples of milk for contact times of 10, 20, 40, 80, and 160 seconds. The range of the standard deviations was found to be ± 0.51 to ± 0.16 mg. for increasing contact times. The extent of calcium removed for these contact periods ranged from 11.2 to 31.1 mg. The average per cent error for all contact times based

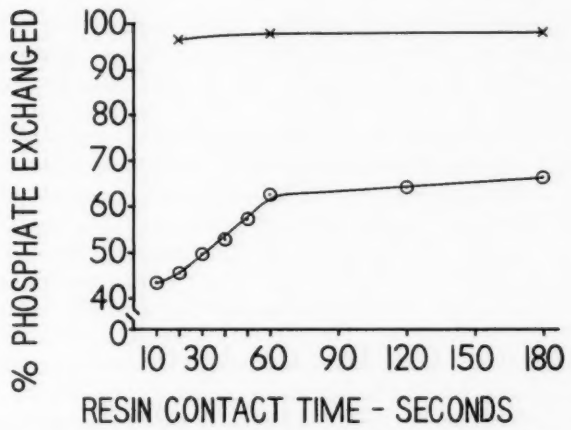


FIG. 2. The exchange of phosphate from raw skimmilk by Amberlite IR-4B-C1. Resin-contact time studies.

(O——O) Phosphate exchanged from milk (average of two runs).

(×——×) Phosphate exchanged from a true solution of KH_2PO_4 and K_2HPO_4 containing 10 meq. PO_4/100 ml.

Note: Quantity of resin 30 ml.; exchange capacity 60 meq. Sample volume 25 ml.

upon all of the values of an average deviation of a single determination was $\pm 1.64\%$ of the amount exchanged, with a range of ± 2.43 to $\pm 0.35\%$ for increasing contact times. The average standard deviation (± 0.38) and average per cent error include the results of at least 15 determinations.

Figure 2 shows the results of two independent resin-contact time studies on removal of phosphorus. The pH of the effluent gradually decreased when the milk was equilibrated with Amberlite IR-4B in the chloride form. After a 90-second or longer equilibration period, the isoelectric point was reached and the protein coagulated. The decrease in pH during the resin-contact equilibration range causes the equilibria of the phosphate systems in milk to shift to more soluble states than those normally found. The results (Figure 2) present the pattern of removal by the resin Amberlite IR-4B-Cl as affected by pH (6.7 original to 5.0 at 60 seconds contact). Experiments are under way employing buffered resins and mixtures of various anion exchange resins to obviate this pH change. These data will be published later. With a resin-contact time of 10 seconds the removal of phosphorus was 43 to 44%. This removal continued at a nearly constant rate with time to the 60-second contact period. At this contact time the per cent phosphorus removed leveled off at near 65%, the curve becoming nearly parallel to the abscissa. The extent of removal of phosphate ions from a true solution, as a function of time, is also given in Figure 2. The true solution contained equivalent amounts of the mono- and dibasic-potassium phosphates. From these data it may be concluded that about one-third of the phosphate in milk is organically bound and not available for exchange to ion-exchange resins. This is in agreement with data reported by Ling *(9)*.

An insoluble ion-exchange resin acts as though it were in true solution and gives a direct measure of the amount of ionic calcium and phosphate available for a chemical reaction in a given sample for a definite time. The changes in the slopes of the curves (Figures 1 and 2) of resin-contact time against per cent exchanged show the comparative quantities of calcium which are available to the resin from their natural states in milk and of phosphorus which are available from the milk under the conditions of this experiment. A semi-log plot (Figure 1) of concentration versus contact time for calcium removal from the skimmilk shows a change in the rate constant in the 150-180 second contact time range. This change in the rate constant of removal can be interpreted as caused by the competition of the various components in milk and the active sites on the ion exchange resin for the calcium. The various component forms of calcium are considered as ionic, complexed and/or colloidal. The slope obtained with short resin contact times (10 to 180 seconds) is interpreted as due to exchange of calcium from the ionic and dissolved complexes, whereas the second slope with contact times of the order of 3 to 5 minutes represents exchange of ions from colloidal phases.

Under the conditions of this experiment, the curve (Figure 2) indicates a constant rate of removal of inorganic phosphate to the 65% level, but there is very limited exchange of the organic phosphate present if the assumption is made that about one-third of the total phosphorus is present as organically bound phosphorus.

Since the slopes of the equilibration curves are finite, it is indicated that an appreciable time is required to remove calcium or phosphate from the various states in which they exist in milk and that small amounts from these states are being removed, even at the 10-second time interval. However, these times are quite short and indicate that any measurement of the ionic calcium or phosphate of milk must be instantaneous, or must be of such a nature that no disturbance of the equilibria in milk is brought about.

SUMMARY

An ion-exchange resin-contact time equilibration procedure has been developed for the study of the inorganic equilibria of cations and anions in raw skimmilk and processed milks. With this method it is possible to study directly changes in the cation-anion components of milk and the various phases involved, as a function of processing conditions. Data are presented to show removals of calcium and phosphorus from raw skimmilk and true solutions at various contact times. Thirty-six per cent of the total calcium was removed from milk during 10 seconds contact. The rate constant for the removal of calcium was found to remain constant to the 90% level, after which the rate constant decreased.

The reproducibility of the resin-contact time method for calcium was considered good. The average standard deviation was found to be ± 0.38 mg., and the average error for all contact times studied was $\pm 1.64\%$ of the per cent exchanged.

With a 10-second contact time about 44% of the total phosphorus was ex-

changed. A nearly constant rate of removal occurred as a function of contact time to the 65-68% removal point. The removal leveled off at this time. These studies indicate that about one-third of the phosphate in milk is organically bound and not available as ions.

The slopes of the curves for contact times of 10 to 180 seconds are interpreted as due to the exchange of calcium from the ionic and dissolved complexes, whereas the slopes for contact times of 3 to 5 minutes are due to exchange from colloidal phases.

The resin-contact time method does not have many of the uncertainties inherently present in methods such as dialysis, ultrafiltration, centrifugation, and rennet and other precipitation techniques.

ACKNOWLEDGMENT

The authors wish to express their appreciation to J. M. McIntire, Chief, Dairy, Oil, and Fat Products Div., Food Laboratories, the Quartermaster Food and Container Institute for the Armed Forces, Chicago, for his interest and cooperation in this investigation.

REFERENCES

(1) Association of Official Agricultural Chemists. *Official Methods of Analysis.* 7th ed. A.O.A.C., Washington, D. C. 1950.

(2) Davies, L. W. Zeolites as Analytical Reagents for the Examination of the Kations of Milk. *Compt. rend. 5th congr. intern. tech. et chim. ind. agr. Vol. II,* p. 291. 1937.

(3) Gehrke, C. W., Affsprung, H. E., and Lee, Y. C. The Determination of Calcium in Biological Materials by an Ion-Exchange Modified Ethylenediamine Tetraacetate Titration Procedure. Submitted to *J. Agr. and Food Chem.* 1954.

(4) Gehrke, C. W., and Almy, E. F. The Action of Mineral Ion Exchange Resins on Milk Constituents. *Ind. Eng. Chem.*, **42**: 2344. 1950.

(5) Gehrke, C. W., and Almy, E. F. The Action of Mineral Ion Exchange Resins on Certain Milk Constituents. *Science*, **110**: 556. 1949.

(6) Hankinson, C. L., Ellertson, M. E., and Gleim, Wm. Studies of the Effect of Heat on Milk Dialysates. *J. Dairy Sci.*, **29**: 727. 1946.

(7) Jenness, R. The Effect of Heat on Ionic Equilibria with Particular Reference to Calcium and Phosphorus. Personal communication, and paper presented at the 47th annual A.D.S.A. meeting, Davis, Calif. June, 1952.

(8) Lampitt, L. H., Bushill, J. H., and Filmer, D. F. Dialysis of Milk, III. Salt Equilibrium with Special Reference to Calcium, Magnesium, and Phosphorus. *Biochem. J.*, **31**: 1861. 1937.

(9) Ling, E. R. *A Textbook of Dairy Chemistry.* 2nd ed. Vol. I. Chapman and Hall, Ltd., London. 1946.

(10) Mattick, E. C. V., and Hallett, H. S. The Effect of Heat on Milk. *J. Agr. Sci.*, **19**: 452. 1929.

(11) Pyne, G. T. On the Use of Various Sera for the Determination of the Soluble Calcium and Phosphorus in Milk. *J. Dairy Sci.*, **11**: 292. 1940.

(12) Seekles, L., and Smeets, W. Th. G. M. The Stability of Milk in Relation to the Concentration of Calcium Ions. Personal communication. 1952.

(13) Smeets, W. Th. G. M. The Determination of Calcium Ions Concentration in Milk Ultrafiltrate. Ph.D. dissertation, State University of Utrecht, The Netherlands. 1952. Note published in *Nature*, **169**: 802. 1952.

(14) Storrs, A. B. A Test for the Protein Stability of Milk. *J. Dairy Sci.*, **25**: 19. 1942.

(15) Verma, I. S. A Study of the State of Solution of the Naturally Occurring Salts in Milk. Ph.D. dissertation, Univ. of Wisconsin. 1950.

FROZEN HOMOGENIZED MILK. IX. FREEZING CHARACTERISTICS OF HOMOGENIZED AND UNHOMOGENIZED MILK

C. J. BABCOCK AND D. R. STROBEL
Livestock Products Division, Foreign Agricultural Service, USDA
AND
LT. COLONEL R. H. YAGER AND E. S. WINDHAM
Veterinary Division, Army Medical Service Graduate School, Walter Reed Army Medical Center, Washington, D. C.

Previous studies *(1, 2, 3, 4, 5, 6, 7, 8)* have revealed that various factors affect the keeping quality of frozen homogenized milk. Two of these studies *(2, 3)* established that when homogenized milk is frozen, the solid components tend to concentrate in the lower portion of the sample and that apparently there is no further movement of these solids after the milk is frozen. Baldwin and Doan *(9)* reported that: *(a)* the fat concentration in the frozen and unfrozen portions over the entire range of freezing is dependent upon the cream rising phenomena of the milk; *(b)* when the creaming ability is destroyed, the fat concentration of the unfrozen portion increased progressively with the degree of freezing, whereas that of the frozen portion decreased at first, but finally approached the fat percentage of the original milk; and *(c)* increased fat concentrations retarded the diffusion or concentration of the milk constituents into the unfrozen portion of the freezing products.

Since the literature does not contain detailed information regarding the movement of milk constituents during various stages of freezing, with analytical analyses of different portions of frozen and unfrozen milk and with a comparison between homogenized and unhomogenized milk, the present study was undertaken to establish these facts on both homogenized and unhomogenized milk.

EXPERIMENTAL RESULTS

Homogenized and unhomogenized milk from a commercial dairy, packaged in 1-qt. paper containers, was used for three series of samples. Initial tests for fat, protein, total solids, and ash were made in accordance with official procedures. The samples were then stored at −20° C. for freezing. After 3 hours, the first set of samples (1 qt. homogenized, 1 qt. unhomogenized) was removed for testing. It was found that freezing had begun at the top and bottom of the samples but that the center portion was still liquid. The liquid portions were pipetted from the two containers and the frozen sections were divided into top and bottom sections. The liquid and frozen sections were then analyzed for total solids, fat, protein, and ash. One hour later, the second set of samples was removed from the freezer. At this time, freezing had progressed so that the remaining unfrozen liquid was enclosed by a continuous frozen mass. The top frozen sections of the homogenized and unhomogenized samples were pierced,

Received for publication May 20, 1954.

TABLE 1

Average analyses of fat, protein, total solids, and ash of different sections of three series of samples of homogenized and unhomogenized milk during the freezing process

Time in freezer (hours)	Fat (%)								Protein (%)							
	Unfrozen section		Frozen sections						Unfrozen section		Frozen sections					
			Top		Middle		Bottom				Top		Middle		Bottom	
	H[a]	U[b]	H	U	H	U	H	U	H	U	H	U	H	U	H	U
0	3.58	3.80	—	—	—	—	—	—	3.23	3.19	—	—	—	—	—	—
3	3.78	4.03	2.70[c]	3.17[c]	—	—	3.86	3.46	3.46	3.41	2.35[c]	2.37[c]	—	—	3.38	3.26
4	3.99	4.02	2.50	3.80	2.56	2.95	3.82	3.57	3.56	3.49	2.17	2.14	2.19	2.35	3.43	3.25
5	4.04	3.89	2.47	4.54	2.54	2.97	3.87	3.18	3.65	3.55	3.15	2.19	2.18	2.18	3.47	3.31
6	4.14	3.68	2.55	5.57	2.73	2.77	3.58	3.35	3.75	3.65	2.17	2.31	2.35	2.24	3.20	3.33
7	4.33	3.69	2.55	5.34	2.83	2.78	4.08	3.40	3.91	3.81	2.19	2.14	2.44	2.27	3.67	3.48
8	4.46	3.10	2.55	6.75	2.85	2.61	4.09	2.49	4.08	3.96	2.20	2.27	2.48	2.41	3.70	3.62
9	4.69	3.77	2.60	5.06	3.16	2.77	4.27	3.54	4.30	4.17	2.21	2.31	2.66	2.38	3.85	3.64
10	4.78	3.77	2.76	5.08	3.23	2.79	4.41	3.52	4.40	4.19	2.37	2.27	2.80	2.54	3.96	3.75
	Total solids (%)								Ash (%)							
0	12.29	12.44	—	—	—	—	—	—	0.72	0.72	—	—	—	—	—	—
3	13.21	13.26	8.81[c]	9.38[c]	—	—	12.59	12.29	0.79	0.79	0.52[c]	0.53[c]	—	—	0.73	0.73
4	13.84	13.60	8.13	9.39	8.34	8.87	12.86	12.26	0.83	0.82	0.47	0.46	0.48	0.49	0.75	0.73
5	14.06	13.68	8.01	10.39	8.24	8.74	13.07	12.36	0.84	0.83	0.46	0.48	0.47	0.48	0.76	0.77
6	14.46	13.78	8.29	11.74	8.95	8.73	13.24	12.25	0.88	0.87	0.48	0.51	0.52	0.49	0.78	0.75
7	15.12	13.43	8.30	11.18	9.24	9.11	13.83	12.70	0.93	0.90	0.49	0.50	0.55	0.50	0.82	0.78
8	15.75	13.88	8.36	12.81	9.33	8.99	13.90	12.40	0.95	0.93	0.49	0.51	0.55	0.54	0.82	0.81
9	16.69	15.36	8.40	10.82	10.05	9.10	14.59	13.49	1.02	0.99	0.51	0.47	0.57	0.53	0.87	0.83
10	17.09	15.99	9.06	11.08	10.48	9.53	15.03	13.69	1.04	1.01	0.54	0.51	0.64	0.58	0.91	0.87

[a] Homogenized.
[b] Unhomogenized.
[c] First series of samples not divided; upper 2/3 of samples of second and third series.

and the liquid centers were pipetted out. The frozen mass of each sample was then divided into top, middle, and bottom sections. All sections were then analyzed. This procedure was followed at hourly intervals until the liquid center in each quart of milk had been reduced to a volume of less than 150 ml. After the samples were completely frozen, they were divided into six equal parts and each part was analyzed for fat, protein, total solids, and ash.

The homogenized and unhomogenized milk used in the three series of samples was of the same quality, from the same commercial dairy, and processed and packaged in the same manner. The average percentages of fat, protein, total solids, and ash contents were 3.58, 3.23, 12.29, and 0.72 for homogenized milk; 3.80, 3.19, 12.44, and 0.72 for unhomogenized milk.

Table 1 shows that as the homogenized and unhomogenized milk froze there was a gradual but constant increase in the percentage of protein, total solids, and ash in the unfrozen portion of the samples and that there was a greater increase in the concentration of these components in the homogenized milk than in the unhomogenized milk. Fat in the unfrozen portion of the unhomogenized milk at first decreased and then increased, and the fat in the homogenized milk increased.

As freezing progressed in the homogenized milk, the fat content of the top sections showed only slight variations but the middle and bottom sections showed a constant increase. In the unhomogenized milk, the fat content of the top sections showed a constant increase, the middle sections showed a decrease with slight fluctuations, and the bottom sections showed an increase, a decrease, and then an increase.

In the frozen sections the homogenized milk showed an increase with only two fluctuations of over 0.2 in the percentage of protein, total solids, and ash contents. The unhomogenized milk showed a final increase in the percentage content in all sections, but fluctuating increases and decreases occurred during the course of freezing. The results in Table 2 support earlier findings *(2, 3)* that when homogenized milk is frozen the solid components tend to concentrate in the lower portion of the sample. In unhomogenized milk the fat concentrates in the upper portion of the sample while the protein and the constituents that

TABLE 2

Averages of analyses of six equal sections from top to bottom of three series of samples of homogenized and unhomogenized milk after completion of the freezing process

Sections (top to bottom)	Fat *(%)*		Protein *(%)*		Total solids *(%)*		Ash *(%)*	
	H[a]	U[b]	H	U	H	U	H	U
1	3.17	6.85	2.73	2.77	10.61	13.94	0.64	0.58
2	2.75	3.08	2.38	2.42	9.08	9.44	0.56	0.55
3	3.31	2.91	2.91	2.83	11.18	10.60	0.67	0.67
4	3.61	3.27	3.31	3.28	12.87	12.23	0.78	0.77
5	4.15	3.48	3.65	3.63	14.26	13.42	0.85	0.86
6	4.37	3.57	4.04	3.99	15.37	14.40	0.90	0.92
Before freezing	3.58	3.80	3.23	3.19	12.29	12.44	0.72	0.72

[a] Homogenized.
[b] Unhomogenized.

constitute the ash concentrate at approximately the same rate and proportion as for homogenized milk.

SUMMARY AND CONCLUSIONS

Except for fat movement, homogenized and unhomogenized milk showed similar freezing characteristics during freezing at –20° C. In both milks, there was a gradual but constant increase in the percentage of protein, total solids, and ash in the unfrozen portions. In the frozen sections (when divided into top, middle, and bottom), both milks showed a final increase in protein, total solids, and ash contents over the earlier observations. As freezing progressed, the bottom sections of both milks showed a final increase in fat content. The fat content of the homogenized milk increased in the middle section, whereas that of the unhomogenized milk decreased slightly. The top section of the homogenized milk showed slight variations in fat and that of the unhomogenized showed a constant increase.

After freezing was completed, the homogenized and unhomogenized milks showed a similar concentration in the lower portion of the sample of protein and milk constituents that would constitute the ash. The fat content of the unhomogenized milk concentrated in the upper portion of the sample.

REFERENCES

(1) Babcock, C. J., Roerig, R. N., Stabile, J. N., Dunlap, W. A., and Randall, R. Frozen Homogenized Milk. I. Effects of Freezing and Storage Temperatures on the Physical Characteristics of Homogenized Milk. *J. Dairy Sci.*, 29: 699. 1946.

(2) Babcock, C. J., Roerig, R. N., Stabile, J. N., Dunlap, W. A., and Randall, R. Frozen Homogenized Milk. II. Effect of Freezing and Storage Temperatures on the Chemical and Bacteriological Properties of Homogenized Milk. *J. Dairy Sci.*, 30: 49. 1947.

(3) Babcock, C. J., Stabile, J. N., Randall, R., and Windham, E. S. Frozen Homogenized Milk. III. Stability of Milk Solids Distribution in Frozen Homogenized Milk. *J. Dairy Sci.*, 30: 733. 1947.

(4) Babcock, C. J., Stabile, J. N., Randall, R., and Windham, E. S. Frozen Homogenized Milk. IV. Keeping Quality of Frozen Homogenized Milk after Thawing. *J. Dairy Sci.*, 31: 805. 1948.

(5) Babcock, C. J., Stabile, J. N., Windham, E. S., Evans, L. B., and Randall, R. Frozen Homogenized Milk. V. Effect of Age Before Freezing on the Keeping Quality of Frozen Homogenized Milk. *J. Dairy Sci.*, 31: 811. 1948.

(6) Babcock, C. J., Stabile, J. N., Windham, E. S., and Randall, R. Frozen Homogenized Milk. VI. The Use of Stabilizers in Frozen Homogenized Milk. *J. Dairy Sci.*, 32: 175. 1949.

(7) Babcock, C. J., Windham, E. S., and Randall, R. Frozen Homogenized Milk. VII. Effect of Agitation During Freezing on the Keeping Quality of Frozen Homogenized Milk. *J. Dairy Sci.*, 32: 812. 1949.

(8) Babcock, C. J., Strobel, D. R., Yager, R. H., and Windham, E. S. Frozen Homogenized Milk. VIII. Effect of the Addition of Sucrose and Ascorbic Acid on the Keeping Quality of Frozen Homogenized Milk. *J. Dairy Sci.*, 35: 195. 1952.

(9) Baldwin, F. B., Jr., and Doan, F. J. Observations on the Freezing of Milk and Cream. I. The Effect of Fat Concentration upon the Distribution of Constituents in the Frozen and Unfrozen Portions of Partially Frozen Milk and Cream. *J. Dairy Sci.*, 18: 629. 1935.

BODY WEIGHTS, BODY MEASUREMENTS, AND SURFACE AREA OF JERSEY AND SINDHI-JERSEY (F_1) CROSSBRED FEMALES

R. E. McDOWELL, DOUGLAS H. K. LEE,[1] H. W. McMULLAN,
M. H. FOHRMAN, AND W. W. SWETT
Dairy Husbandry Research Branch, Agricultural Research Service
USDA, Beltsville, Md.

In the cross-breeding investigations conducted as a part of the Cooperative Southern Regional Dairy Cattle Breeding Project, two groups of dairy cattle have been established at Beltsville, one of purebred Jerseys, the other of F_1 crosses of Red Sindhi (a Zebu breed) with Jerseys. From the studies previously reported *(6)* it has been shown that the crossbred have a greater heat tolerance than the Jerseys. In the process of endeavoring to determine the animal characteristics responsible for these observed differences, one of the first questions to arise was whether they might be due to body size or other morphological characters. In any crossbreeding investigation, moreover, it is interesting to know how the crossbred progeny compare in size and body form with the parent breeds and whether or not the crossbreds exhibit any evidence of heterosis or so-called "hybrid vigor."

In this paper Sindhi-Jersey (F_1) crosses are compared with their Jersey dams in respect to weight and with comparable Jerseys in respect to surface area and body form, as indicated by body measurements.

METHODS

All crossbred animals in this study were raised in the same way as those in the purebred herds at Beltsville, where the feeding and management conform to good dairy practice. Whole milk is fed for the first 4 to 8 weeks, depending upon the vigor of the calf. After this, skimmilk is fed up to 6 months of age. From about 3 weeks of age, the calves are fed alfalfa hay and a small amount of grain. The grain ration is gradually increased to a maximum of 3 lb. daily by the time that skimmilk feeding is discontinued.

For heifers over 6 months of age and for dry cows the ration consists of 4 lb. of grain, and hay ad libitum. During lactation, hay, silage, and grain are fed in proportion to milk production and body weight. With the exception of the first lactation, when the animals are barn-fed, pasture is used in season.

Mean body weight, up to 12 months of age, is based on an average of weights taken on three consecutive days, at 30-day intervals. From 12 months through 21 months, the means are based on single day weights.

For lactating cows, the mean is based upon the average of monthly weights taken over the first 10 months of lactation, adjusted for age differences due to calving by reference to the growth standard for Beltsville Jerseys *(4)*.

Received for publication June 7, 1954.

[1] Professor of physiological climatology, Johns Hopkins University, Baltimore, Md.

Fifteen external measurements, selected from 27 employed by the Dairy Husbandry Research Branch for studying the relationship between body form and milk production *(8)*, were used as indicators of body form. Values obtained on the crossbred animals are compared with the Beltsville herd average for Jerseys (unpublished data). This is considered more desirable than comparisons with standards which may be better known but which are derived from animals maintained under different conditions. In the first lactation group, direct daughter-dam comparisons were available and have been included as well.

Body surface measurements were made with a surface integrator which consists of two wheels, the circumferences of which are known, mounted a fixed distance apart, and geared to a revolution counter. One wheel has a roughened surface which rubs off chalk onto the hair coat as it is pushed over the surface. The surface area is measured on one side of the animal, with the animal standing squarely on all four feet, according to a routine which has been described previously *(5)*.

RESULTS AND DISCUSSION

Body weight. Figure 1 shows the comparative increase in body weight of Sindhi-Jersey (F_1) crosses and their Jersey dams, from birth to 21 months of age, and the average of the first ten monthly weights during the first, second, and third lactations adjusted as described above. The values for heifers are based on 45 pairs at birth, gradually decreasing to 31 pairs at 21 months of age. The lactation means are for 24, 18, and 11 pairs for the first, second, and third lactations, respectively.

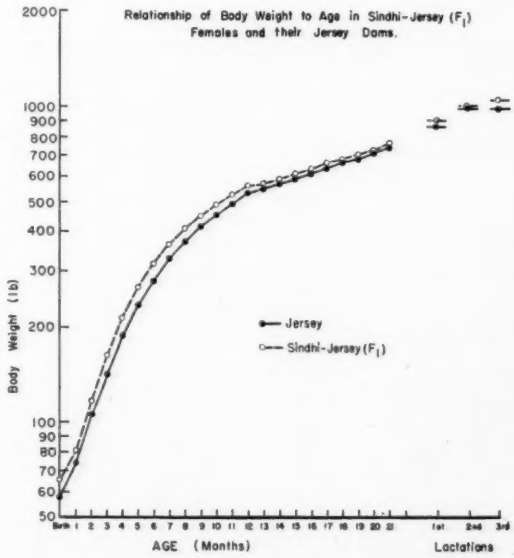


FIG. 1.

On the logarithmic scale, the slope of the line indicates the rate of growth independently of body size. The vertical distance between the two curves indicates the proportional difference in weights. The data indicate that the crossbred animals gain weight more readily than the Jerseys at the earlier ages and maintain some of this gain even through the third lactation.

The differences between the Jersey dams and the crosses are highly significant (1% level) from birth through 15 months of age. From 16 to 21 months of age, the differences are not significant. The difference is highly significant (1% level) during the first lactation but is not significant in the later lactations. These differences are even greater than those reported by Rathore *(7)*, who found that crossbred females exceeded pure Red Sindhis by 12% in body weight at 2 years of age.

The average coefficient of variation in the weights for the crossbred heifers is substantially the same (8.1%) as that of the Jerseys (8.7%).

When the mean weights of the Jersey dams are compared with the Beltsville herd average for Jerseys *(4)*, they tend to be slightly larger than the herd average, but the differences are not significant.

The size of the crossbreds has been somewhat surprising, since purebred Red Sindhis are smaller than Jerseys. Joshi and Phillips *(3)* give the average weight of Red Sindhi calves at birth as 40 to 45 lb. for the females and 42 to 48 lb. for males; the average weight for females at 12 months of age as 330 to 340 lb.; at 24 months, 515 to 525 lb.; at 36 months, 640 to 650 lb.; and at maturity, 650 to 700 lb. These weights may be influenced to a certain degree by the adverse environment of India. Four Sindhi females born at Jeanerette, Louisiana, aver-

TABLE 1

Comparative body measurements of Jerseys and Sindhi-Jersey crosses at 6 months of age

Item of measurement	Jerseys[a]		Crossbreds[b]		Differences
	Herd av.	Standard error	Mean	Standard error	
	(cm.)		*(cm.)*		*(cm.)*
Height at withers	95.48	0.239	98.20	0.472	+2.72**
Height at hips	97.75	0.233	100.95	0.417	+3.20**
Length of leg (foreleg)	51.04	0.160	52.76	0.467	+1.72**
Depth of forechest	44.44	0.131	45.34	0.213	+0.90**
Width of forechest	23.35	0.135	25.14	0.250	+1.79**
Width of hips	27.36	0.109	27.94	0.169	+0.58**
Width of pins	16.71	0.094	17.80	0.225	+1.09**
Body length (withers to hips)	58.46	0.190	57.50	0.439	−0.96*
Length of rump	29.08	0.108	27.81	0.248	−1.27**
Angle of rump (°)	−2.26	0.244	−8.75	0.607	+6.49**
Total body length (withers to pins)	87.39	0.092	85.62	0.474	−1.77**
Circumference of forechest	113.49	0.363	118.33	0.734	+4.84**
Circumference of paunch	139.82	0.575	141.99	0.678	+2.17**
Length of head (poll to mouth)	33.49	0.106	36.40	0.156	+2.91**
Width of head (width of eyes)	16.48	0.059	16.80	0.089	+0.32**

[a] Data on 193 animals at Beltsville.

[b] Data on 36 crossbreds.

** Significant at the 1% level.

* Significant at the 5% level.

aged 43 lb. at birth, 202 lb. at 6 months, 334 lb. at 12 months, and 408 lb. at 18 months of age.

Joshi and Phillips give the average weight of mature Sindhi males as 950 to 1,000 lb. Of the three F_1 crossbred males used at Beltsville, one weighed 1,678 lb. at 3 years and 6 months, one weighed 1,488 lb. at 3 years and 1 month, and the third weighed 1,408 lb. at 2 years and 1 month of age. These weights indicate as great or greater increase in weight in the F_1 males as was shown in the females.

The larger size of the female crosses during the three lactation periods is associated in part with the fact that they usually showed a smaller decrease in body weight after calving and recovered more quickly to their normal weight.

Body measurements. Tables 1, 2, 3, and 4 give the comparative body measurements of Jerseys and Sindhi-Jersey (F_1) crosses at 6, 12, and 18 months of age and at first lactation, respectively. Table 1 shows that the crossbreds are taller and have greater body width and depth but that the length of body (withers to hips) and length of rump are shorter than those of the Jerseys. The most significant differences at 6 months of age are in the angle of rump and length of head.

From Tables 2, 3, and 4 it will be seen that in most cases the differences between the two groups diminish with age to a nonsignificant value or actually become reversed. The angle of rump and length of head, however, are greater in the crosses at all ages.

Table 4 also includes the means and standard errors for the Jersey dams. It will be seen that the means for the Jersey dams are very similar to those of the herd average. The average coefficient of variation of the dams and crossbred

TABLE 2

Comparative body measurements of Jerseys and Sindhi-Jersey crosses at 12 months of age

Item of measurement	Jerseys[a]		Crossbreds[b]		Differences
	Herd av.	Standard error	Mean	Standard error	
	(cm.)		*(cm.)*		*(cm.)*
Height at withers	110.03	0.201	110.81	0.501	+0.78
Height at hips	111.94	0.195	112.93	0.463	+0.99*
Length of leg (foreleg)	54.90	0.151	56.12	0.381	+1.22**
Depth of forechest	55.13	0.115	54.73	0.213	−0.40
Width of forechest	30.76	0.157	31.66	0.242	+0.90**
Width of hips	36.30	0.106	35.81	0.218	−0.49*
Width of pins	22.50	0.122	22.32	0.192	−0.18
Body length (withers to hips)	70.38	0.206	68.03	0.534	−2.35**
Length of rump	35.57	0.103	33.42	0.248	−2.15**
Angle of rump (°)	−2.85	0.257	−9.72	0.585	+6.87**
Total body length (withers to pins)	105.95	0.242	101.45	0.584	−4.50**
Circumference of forechest	142.15	0.365	144.16	0.502	+2.01**
Circumference of paunch	171.32	0.644	171.47	1.036	+0.15
Length of head (poll to mouth)	39.88	0.108	42.76	0.197	+2.88**
Width of head (width of eyes)	19.13	0.058	18.93	0.127	−0.20

[a] Data on 198 animals in the Beltsville herd.

[b] Data on 32 crossbreds.

** Significant at the 1% level.

* Significant at the 5% level.

TABLE 3

Comparative body measurements of Jerseys and Sindhi-Jersey crosses at 18 months of age

Item of measurement	Jerseys[a]		Crossbreds[b]		Differences
	Herd av.	Standard error	Mean	Standard error	
	(cm.)		*(cm.)*		*(cm.)*
Height at withers	117.18	0.196	117.48	0.493	+0.30
Height at hips	118.83	0.198	118.55	0.575	−0.28
Length of leg (foreleg)	56.30	0.153	58.00	0.337	+1.70**
Depth of forechest	60.85	0.133	59.43	0.266	−1.42**
Width of forechest	34.35	0.168	35.05	0.333	+0.70*
Width of hips	41.23	0.128	40.15	0.254	−1.08**
Width of pins	25.99	0.122	25.29	0.286	−0.70*
Body length (withers to hips)	76.74	0.230	73.51	0.586	−3.23**
Length of rump	38.91	0.101	36.30	0.297	−2.61**
Angle of rump (°)	−4.20	0.254	−10.17	0.775	+5.97**
Total body length (withers to pins)	115.64	0.269	109.64	0.641	−6.00**
Circumference of forechest	157.01	0.437	156.22	0.713	−0.79
Circumference of paunch	183.93	0.665	178.75	1.668	−5.18**
Length of head (poll to mouth)	43.13	0.118	45.78	0.269	+2.65
Width of head (width of eyes)	20.48	0.058	20.05	0.166	−0.43*

[a] Data on 191 animals in the Beltsville herd.

[b] Data on 30 crossbreds.

** Significant at the 1% level.

* Significant at the 5% level.

daughters was substantially the same for the two groups (6.06 and 6.12%, respectively). This indicates that the crosses were as uniform with respect to body form as their dams at the time of measurement.

The available data on body measurements of pure Red Sindhis are very limited. Table 5 presents the average measurements for four body dimensions for Sindhis in India as given by Joshi and Phillips *(3)*. The data show that Sindhis in India are definitely smaller in all respects than the Jerseys at Beltsville.

The summary comparison, based on the t test of significance, for the difference between the Jersey herd average and the F_1 crosses, for all ages, is given in Table 6. From this table it can readily be observed that the advantage in height of the crosses at 6 months diminishes to a nonsignificant value at later ages. The crosses also show greater depth, width, body circumference, and width of head at 6 months of age. These values become nonsignificant or significant in favor of the Jersey during first lactation. The Jerseys appear to have a greater body length at all ages. The differences between the two groups for angle of rump and length of head are significantly greater (1% level) for the crosses at all ages.

Surface area. In a previous publication *(5)*, preliminary measurements of surface area made on 20 Jersey and 20 Sindhi-Jersey crossbred animals were published. Since that time, more animals have been measured, but no substantial change occurred in the results. The data obtained on the larger group are given in Table 7.

From this it will be seen that there is no significant difference between the Jerseys and the crossbreds in relative surface area. It would seem that any

TABLE 4

Comparative body measurements of Jersey and Sindhi-Jersey crosses made 3 months after calving during first lactation

Item of measurement	Jersey dams		Jerseys		Crossbreds		
	Mean[a]	Std. error	Herd av.[b]	Std. error	Mean[c]	Std. error	Differences[d]
	(cm.)		*(cm.)*		*(cm.)*		*(cm.)*
Height at withers	122.17	0.629	123.29	0.200	122.36	0.573	−0.93
Height at hips	123.00	0.591	123.45	0.205	123.42	0.658	−0.03
Length of leg (foreleg)	57.47	0.433	57.38	0.190	58.02	0.446	+0.64
Depth of forechest	64.79	0.398	65.91	0.164	64.34	0.266	−1.57**
Width of forechest	36.24	0.425	38.27	0.199	37.69	0.401	−0.58
Width of hips	46.78	0.274	47.67	0.169	45.55	0.315	−2.12**
Width of pins	28.49	0.249	29.01	0.148	27.39	0.267	−1.62**
Body length (withers to hips)	82.27	0.433	82.73	0.214	79.57	0.747	−3.16**
Length of rump	42.68	0.211	42.89	0.137	39.17	0.245	−3.72**
Angle of rump (°)	−4.78	0.501	−4.32	0.240	−10.30	0.823	+5.98**
Total body length (withers to pins)	124.91	0.527	125.74	0.095	118.74	0.944	−7.00**
Circumference of forechest	167.76	0.811	171.01	0.528	168.95	0.745	−2.06*
Circumference of paunch	202.35	1.339	207.28	0.751	201.68	0.890	−5.60**
Length of head (poll to mouth)	45.55	0.248	46.01	0.117	48.75	0.288	+2.74**
Width of head (width of eyes)	21.54	0.176	21.41	0.060	20.00	0.496	−1.41**

[a] Mean for 22 Jersey dams; average age 2 yr., 4 mo.
[b] Data on 193 animals in the Beltsville herd, average age 2 yr., 4 mo.
[c] Mean for 22 F_1 crossbreds; average age 2 yr., 4 mo.
[d] Difference between crossbred mean and Jersey herd average.
** Significant at the 1% level.
* Significant at the 5% level.

increase in surface area that the crossbreds may gain from dewlap development is offset by other contour changes, such as the roundness of the hips, which result in corresponding decreases.

From these figures it also will be seen that the correlation between surface area and body weight is not significantly improved if the comparison is made to the two-thirds power of body weight instead of to weight directly. As was previously pointed out *(5)*, the measurements reported by Brody and Elting *(1)* are similarly unaffected by substituting the two-thirds power for the direct body weight, as long as adult animals are being considered.

On the other hand, when the data of Hogan and Skouby *(2)*, quoted by Elting and Brody, are examined, it appears that a better correlation is obtained even in their adult animals when a power of body weight is used. This led the authors

TABLE 5

Average measurements of four body dimensions of Red Sindhi cattle in India as reported by Joshi and Phillips (3)

Item of measurement	Age					
	1 year		2 years		Mature	
	No.	Mean	No.	Mean	No.	Mean
		(cm.)		*(cm.)*		*(cm.)*
Height at withers	12	96.62	12	106.02	51	120.73
Depth of forechest	12	47.63	12	60.96	51	62.51
Width of hips	12	28.78	12	33.43	51	42.09
Circumference of forechest	12	117.48	12	133.99	51	158.37

TABLE 6

Summary comparison of body measurements of Jerseys (herd average) and Sindhi-Jersey crosses at various ages

Item of measurement	6 months	12 months	18 months	1st lactation
Height at withers	++	0	0	0
Height at hips	++	+	0	0
Length of leg (foreleg)	++	++	++	0
Depth of forechest	++	0	−−	−−
Width of forechest	++	++	+	0
Width of hips	++	−	−−	−−
Width of pins	++	0	−	−−
Body length (withers to hips)	−	−−	−−	−−
Length of rump	−−	−−	−−	−−
Angle of rump (°)	++	++	++	++
Total body length (withers to pins)	−−	−−	−−	−−
Circumference of forechest	++	++	0	−
Circumference of paunch	++	0	−−	−−
Length of head (poll to mouth)	++	++	++	++
Width of head (width of eyes)	++	0	−	−−

++ Crosses significantly larger (1% level) than Jersey.
+ Crosses significantly larger (5% level) than Jersey.
0 Difference not significant.
− Crosses significantly smaller (5% level) than Jersey.
−− Crosses significantly smaller (1% level) than Jersey.

to subject their own as well as Hogan and Skouby's data to a multiple regression analysis to determine what powers of body weight and total length fit the data best in the expression:

$$A = K\,W^a L^b$$
$$\text{or } \text{Log } A = \log K + a \log W + b \log L$$

Where A is surface area, W is body weight, L is total body length (withers to pin-bones), K is a constant depending upon the units used, and a and b are power constants. The results of these analyses are given in Table 8.

It will be seen that the present authors' results differ considerably from those reported by Hogan and Skouby. It is believed that these differences cannot be attributed to differences in the technique used for measuring surface area but must reflect real differences between the two groups of animals. In adult Jerseys

TABLE 7

Comparisons of surface areas and body weights and the relationships between surface area and body weight for 32 Jerseys and 23 Sindhi-Jersey (F_1) crossbred mature cows

Item	Jersey		Sindhi-Jersey	
	Value	Standard error	Value	Standard error
Surface area *(sq. m.)*	4.26	0.042	4.13	0.067
Body weight *(kg.)*	454.97	6.57	441.43	9.84
S.A. *(sq. cm.)*/B.W.[a]	94.44	0.88	93.60	1.462
Correlation between S.A. and B.W.	0.715	0.167	0.730	0.211
Regression S.A. on B.W.	0.0045	0.0008	0.0050	0.0011
S.A. *(sq. cm.)*/(B.W.)$^{0.67}$	724.57	4.43	712.03	8.15
Correlation between S.A. and (B.W.)$^{0.67}$	0.739	0.161	0.749	0.206

[a] Surface area/body weight.

TABLE 8

Powers of body weight and length giving best fit in prediction formulas for surface area

Authors	Method of measuring surface area	Nature of cattle	Using weight and length			Constant if length discarded (K′)
			Weight power (a)	Length power (b)	Constant (K)	
McDowell *et al.*	Surface integrator	Adult Jerseys	0.4795	0.0496	1790	2277
McDowell *et al.*	Surface integrator	Adult Sindhi-Jerseys	0.4821	−0.0916	3392	2189
Hogan and Skouby	Paper mould	Beef breeds of similar weight	0.2109	0.6651	504	——
Hogan and Skouby	Paper mould	All adult beef animals	0.3136	0.6523	286	——

and Sindhi-Jerseys the authors find total body length to have no significant relationship with surface area, whereas in the beef animals Hogan and Skouby found it to be more marked than the association of body weight with surface area. This may reflect basic differences between beef and dairy breeds, but it may be that the genetic uniformity of the dairy cattle studied by the authors minimizes the possible influence of body length and throws correspondingly into relief the influence of body weight.

If this supposition is true, then within a morphologically uniform breed a good estimate of the surface area could be obtained from the weight alone, preferably using the square root of the body weight as the basis of calculation. Before this is accepted, however, further studies should be carried out within uniform groups of beef animals and among more widely varying breeds of dairy cattle.

SUMMARY

Data are presented on comparative body weights, body dimensions, and the measured surface area of Jerseys and Sindhi-Jersey (F_1) crosses.

The mean body weights of the crossbreds are greater than those of the Jersey dams at comparable ages and stages of lactation. This difference, which may be attributable to "hybrid vigor" in the crossbreds, is most evident from birth to 15 months of age.

Body measurements made at 6, 12, and 18 months of age and during first lactation show that at the earlier ages the crossbreds are taller and have greater body width and depth, but that their body length is less. With the advance of age, the differences for most measurements, other than weight, between the two groups diminish to a nonsignificant value or actually become reversed. The crosses exceed the Jerseys, however, in angle of rump and length of head at all ages. The average coefficients of variation for body weight and body dimensions are substantially the same for both groups.

The surface area was measured on 32 Jersey and 23 Sindhi-Jersey crossbred cows with a surface integrator. These areas were compared with body weights. Neither the ratio of surface area to body weight nor the ratio of surface area to the two-thirds power of body weight shows a significant difference between the two groups. In these animals a statistical analysis indicated that the surface area is related to the square root of body weight but to no appreciable extent to total body length.

REFERENCES

(1) BRODY, S., AND ELTING, E. C. A Formula for Estimating Surface Area of Dairy Cattle. *J. Agr. Research*, 33: 3. 1926.

(2) HOGAN, A. G., AND SKOUBY, D. I. Determination of the Surface Area of Cattle and Swine. *J. Agr. Research*, 25: 10. 1923.

(3) JOSHI, N. R., AND PHILLIPS, R. W. Zebu Cattle of India and Pakistan. *FAO Agricultural Study No. 19*, Rome, Italy. 1953.

(4) MATTHEWS, C. A. Standards for Normal Growth in Weights for Jersey Cattle. USDA *Tech. Bull.* (in press).

(5) McDOWELL, R. E., LEE, D. H. K., AND FOHRMAN, M. H. The Relationship of Surface Area to Heat Tolerance in Jerseys and Sindhi-Jersey (F_1) Crossbred Cows. *J. Animal Sci.*, 12: 4. 1953.

(6) McDOWELL, R. E., LEE, D. H. K., FOHRMAN, M. H., SYKES, J. F., AND ANDERSON, R. A. Rectal Temperature and Responses of Jersey and Sindhi-Jersey F_1 Crossbred Cows to a Standard Hot Atmosphere. *J. Dairy Sci.* (Submitted).

(7) RATHORE, A. Differences in Growth of Red Sindhi and Crosses of Red Sindhi with Jersey, Brown Swiss, Holstein-Friesian, and Guernsey Cattle. Ph.D. thesis, Iowa State College, Ames. 1949.

(8) SWETT, W. W., AND GRAVES, R. R. Relation between Conformation and Anatomy of Cows of Unknown Producing Ability. *J. Agr. Research*, 58: 199. 1939.

A COMPARISON OF FERTILITY OF BOVINE SPERMATOZOA STORED AT 5° C. AND –79° C.

H. O. DUNN,[1] H. D. HAFS,[2] P. J. BUCKNER, G. F. YOUNG, AND E. O. CONRAD
Wisconsin Scientific Breeding Institute, Madison

AND

E. L. WILLETT AND G. L. LARSON
American Foundation for the Study of Genetics, Madison, Wisconsin

Retention of fertilizing capacity of bovine semen diluted 1:100 and stored 24 days at –79° C. and semen diluted 1:4 and stored 1 year at –79° C. has been reported by Rowson and Polge *(11)*. Normal, healthy calves have been born in England from inseminations with frozen semen *(9, 10, 11)*. Dunn *et al. (1, 2, 3)* also have produced conceptions and live calves with frozen semen. Macpherson and Henderson *(6)* obtained favorable results with frozen semen diluted 1:40 in a milk diluter.

There are no reports comparing the relative fertility of unfrozen and frozen semen containing specific numbers of spermatozoa. Likewise, the fertility of frozen semen from several bulls of different breeds has not been reported, although Dunn *et al. (1)* found a highly significant difference among bulls based on motility of spermatozoa thawed from a –79° C. storage temperature. The purpose of this paper is to report breeding results with unfrozen and frozen semen from several bulls when numbers of spermatozoa per individual breeding sample varied and when various containers were used for frozen semen.

EXPERIMENTAL PROCEDURE

Processing of semen. By means of the split sample technique, a portion of each ejaculate was processed as unfrozen semen for storage at 5° C., and the remainder was processed as frozen semen for storage at –79° C. Unless otherwise noted, the diluting medium for unfrozen semen was a yolk–citrate extender containing 50% egg yolk, 50% of 2.9% sodium citrate dihydrate buffer, and sulfanilamide to give a final concentration of 0.3%. To this was added 500γ of dihydrostreptomycin sulfate per milliliter of extender.

Semen was processed for freezing by partially extending the semen samples in a nonglycerol extender containing 50% of 2.9% sodium citrate dihydrate buffer and 50% yolk. After the partially extended semen was cooled from 30° C. to 5° C. in a protective water bath, it was further extended with more of the same extender to one-half the final volume. When streptomycin was included, 1,000γ per milliliter were included in the nonglycerol semen extender to yield a final concentration of 500γ per milliliter. Two to three hours later an equal

Received for publication June 21, 1954.

[1] Present address: New York Artificial Breeders' Co-Operative, Inc., Ithaca, N. Y.
[2] Present address: Department of Animal Husbandry, Cornell University, Ithaca, N. Y.

volume of glycerol-containing citrate buffer was added in five aliquots during a 30-minute period. For field trials 1, 2, and 3, this buffer contained 20% glycerol by volume (v/v) and 2.32% sodium citrate. Based on a preliminary report by Miller and VanDemark *(7)* that 7% glycerol was optimal for survival of spermatozoa thawed from the frozen state, the buffer was changed to contain 14% glycerol (v/v) and 2.50% sodium citrate for field trials 4, 5, and 6. The composition of the two final extenders was therefore 1.90% citrate, 25% yolk, and 10% glycerol (v/v) for the first three trials and 2.00% citrate, 25% yolk, and 7% glycerol (v/v) for the last three trials.

After a 16-hour equilibration period, 1-ml. quantities of glycerolated semen were dispensed into the appropriate semen containers, as described in the separate field trials, and placed in an isopropyl alcohol bath at 5° C. for freezing. Cork-stoppered glass tubes were partially immersed to prevent seepage of alcohol around the corks, whereas all other containers were completely immersed. The temperature of the bath was lowered 0.8° C. per minute with Dry Ice until –15° C. was reached. The freezing rate then was increased to 3° C. per minute according to the method of Polge and Lovelock *(8)*.

Storage, transportation, and thawing procedures. Containers of frozen semen were stored at the laboratory in cardboard boxes or in polyethylene bags beneath Dry Ice in a large, insulated chest. Frozen semen was transported in a Thermos vacuum flask surrounded by crushed Dry Ice. In trial 6, the containers were immersed in alcohol during storage and transportation in the field.

In trials 1 through 4, the thawing temperature of the water baths was lukewarm (30° to 38° C.). In trial 5, the temperature was carefully controlled at 40° C. The samples in trial 6 were thawed in a pint of 5° C. water in a small vacuum bottle. This was done because laboratory studies by Miller and VanDemark *(7)* and preliminary breeding trials by Dunn *et al. (1)* had indicated that 5° C. may have certain advantages over 40° C. for thawing frozen spermatozoa. Since the minimum thawing time was 6 minutes, each sample was placed in the cold water bath when leaving one farm to thaw while traveling to the next farm.

Measurement of fertility. Fertility of all semen samples was measured by calculating the percentage of first service cows not returning to service within 60 to 90 days after breeding. Services made by all field technicians the day after collection were included in the fertility data for unfrozen semen. The effect of glycerol per se on fertility of bovine spermatozoa *(4, 5)* was confounded with the combined effect of freezing and thawing.

RESULTS AND DISCUSSION

Trials 1 and 2. The first two field trials were run in September and October, 1952. Cork-stoppered glass tubes served as containers for the frozen semen. No antibacterial agents were included in the extender for the frozen semen. In trial 1, the average total number of spermatozoa per milliliter was 15 million for the unfrozen semen and 36 million for the frozen semen. In trial 2, the average

concentrations were 17 and 20 million total spermatozoa per milliliter for the unfrozen and frozen semen, respectively. Frozen semen was stored from 1 to 7 days. The 60- to 90-day nonreturn rates are shown in Table 1.

TABLE 1

60- to 90-day nonreturns to first services for unfrozen semen stored at 5° C. and frozen semen stored in cork-stoppered glass tubes at −79° C.

Trial	Bull	Unfrozen (5° C.)		Frozen (−79° C.)		Diff. in % N.R.
		Services	Nonreturns	Services	Nonreturns	
		(No.)	*(%)*	*(No.)*	*(%)*	
1	A	74	81	21	76	− 5
	B	69	67	31	48	−19
	C	138	71	20	60	−11
	Totals and averages	281	73	72	60	−13
2	A	96	61	43	72	+11
	A	130	69	65	54	−15
	D	96	70	52	35	−35
	E	76	70	22	55	−15
	F	103	74	78	60	−14
	G	61	80	27	70	−10
	Totals and averages	562	70	287	56	−14

Only one of the nine collections gave satisfactory nonreturn rates for frozen semen compared to the unfrozen control. The three collections from Bull A showed considerable variation in fertility for both treatments. Post-thawing motility estimations made before samples were taken into the field were 40% or higher for all collections and did not appear to be related to the per cent nonreturns. The first calf produced from these inseminations was born in May, 1953. The first 21 calves born from frozen semen were checked and found to be normal and healthy. There were 8 males and 13 females, including two sets of twin heifers.

In addition to the three collections from Bull A, included in Table 1, a fourth collection from this bull was frozen and stored 4 months in cork-stoppered glass tubes. The 60- to 90-day nonreturn rate for 49 services to samples containing no streptomycin was 55%, and for 69 services to samples containing 500γ of streptomycin the nonreturn rate was 64%. Additional replication would be necessary to make a test of significance of the difference of these two means. In view of supporting laboratory data *(3)*, at least one antibiotic such as streptomycin was satisfactory for frozen semen storage.

Trial 3. A comparison of the fertility of unfrozen and frozen semen was made in a split-plot design with three collections from each of seven Holstein bulls. Semen was collected from one bull each day of the week for three successive weeks during January and February, 1953. Shipments of semen on successive days were rotated among three groups of technicians to enable each technician to breed cows with unfrozen and frozen semen from all breeds. Each group of technicians used unfrozen semen the day after collection and frozen

semen 2 days later. In this trial, 500γ of dihydrostreptomycin sulfate per milliliter was included in both extenders. The dilution rates averaged 1:141 (range 1:66 to 1:254) to give 12 million total spermatozoa per milliiiter. One-ml. portions of frozen semen were stored in 5-ml. polystyrene vials with polyethylene caps.[3] The 60- to 90-day nonreturns are presented in Table 2.

[3] Manufactured by the Insemikit Company, Inc., Baraboo, Wis.

TABLE 2

60- to 90-day nonreturns to first services for unfrozen semen stored at 5° C. and frozen semen stored in polystyrene vials at −79° C. (12 million total spermatozoa per insemination)

Bull	Unfrozen (5° C.)		Frozen (−79° C.)		Diff. in % N.R.
	Services[a]	Nonreturns	Services[a]	Nonreturns	
	(No.)	*(%)*	*(No.)*	*(%)*	
1	91	71	52	44	−27
2	82	76	57	56	−20
3	76	63	79	23	−40
4	77	74	45	56	−18
5	81	69	76	59	−10
6	51	63	70	56	− 7
7	81	56	60	40	−16
Totals and averages	539	68	439	47	−21

[a] Total of services for each of three collections.

The analysis of variance revealed a highly significant difference between treatments ($P < 0.01$), a significant difference among bulls ($P < 0.05$), and no significant difference within bulls. The average number of motile spermatozoa per milliliter of unfrozen and frozen semen, as determined in the laboratory prior to shipment, was 7.8 and 7.1 million, respectively. It was postulated that the low nonreturn rates for frozen semen were partly attributed to seepage of alcohol into the vials and the difficulty of effecting a rapid thawing of the samples in the large plastic vials. This container was not satisfactory for storage of frozen semen.

Trials 4, 5, and 6. The 60- to 90-day nonreturn data for trials 4, 5, and 6 are shown in Table 3. In trial 4, samples of frozen semen from six bulls of the

TABLE 3

60- to 90-day nonreturns to first services for unfrozen semen stored at 5° C. and frozen semen stored at −79° C. in hermetically sealed glass ampules and polyethylene bulbs

	Unfrozen (5° C.)		Frozen (−79° C.)	
	Services	Nonreturns	Services	Nonreturns
	(No.)	*(%)*	*(No.)*	*(%)*
Trial 4	702	69	73[a]	69
Trial 5	2688	71	681[a]	63
Trial 6	1891	74	298[a]	60.7
			313[b]	62.3

[a] Services to samples stored in glass ampules.
[b] Services to samples stored in polyethylene bulbs.

Holstein, Guernsey, Jersey, Brown Swiss, and Angus breeds were stored in hermetically sealed, 2-ml. glass ampules[4] at –79° C. for 3 to 8 weeks. The average number of spermatozoa per insemination was 21 million for unfrozen and 18 million for frozen semen. The fertility rates were the same for both treatments, although the number of services was much smaller for frozen semen.

In trial 5, semen samples from 15 bulls of the same breeds were extended to give an average of 18 million total spermatozoa per milliliter of unfrozen and frozen semen. Storage of frozen semen was 1 to 14 weeks at –79° C. in hermetically sealed glass ampules. Throughout this experiment, technicians were aided by assistants who kept the thawing water at a constant temperature of 40° C. The fertility of the frozen semen was eight percentage units lower than the unfrozen semen.

In trial 6, 15 collections from eight Holstein bulls were stored on a split-sample basis in glass ampules and in polyethylene bulbs[5] up to 4 weeks at –79° C. The bulbs were sealed with polyethylene plugs prior to freezing. To standardize the field operation of removing the thawed samples from the containers, the bulbs were inverted and clipped open on the bottom to permit insertion of the inseminating tube. The difference of 1.6 percentage units in favor of the bulb container was not statistically significant ($P > 0.05$). The fertility of unfrozen semen differed significantly from that of the frozen semen ($P < 0.01$).

In addition to these trials, a few breedings were made with frozen semen samples thawed in the morning and transported at the thawing temperature of 5° C. during the day. The 39 services to four bulls whose semen had been stored up to 12 weeks prior to thawing yielded a 60- to 90-day nonreturn rate of 64%, as compared to 74% for unfrozen semen. The maximum storage from thawing to time of insemination was 8 hours. Additional field experiments are necessary to establish the safe storage period after thawing spermatozoa from the frozen state.

SUMMARY

Six field trials were conducted to compare the fertility of unfrozen semen stored at 5° C. for 1 day with frozen semen stored at –79° C. for periods varying from 1 day to 14 weeks. The average 60- to 90-day nonreturn rate was 71% for 6,663 inseminations with unfrozen semen and 59% for 2,163 inseminations with frozen semen.

The split-sample technique was used to compare the fertility of frozen semen stored at –79° C. in hermetically sealed glass ampules and in polyethylene bulbs. There were 298 inseminations with samples stored in glass ampules and 313 inseminations with samples stored in polyethylene bulbs. The 60- to 90-day nonreturns were 60.7% and 62.3%, respectively. The difference of 1.6 percentage units in favor of polyethylene bulbs as containers for frozen semen was not significant at the 5% level of probability.

[4] Manufactured by Hughes-Murray, Inc., Newark, N. J.
[5] Manufactured by the Insemikit Co., Inc., Baraboo, Wis.

ACKNOWLEDGMENTS

The authors wish to acknowledge the IBM services of the American Breeders' Service, Chicago, for aid in summarization of fertility data, the services of Victor Radandt for supervising field operations, and the cooperation of the technicians of Dane-Iowa, Rock County, and Waukesha Breeders Cooperatives in performing the inseminations.

REFERENCES

(1) Dunn, H. O., Hafs, H. D., and Young, G. F. Laboratory and Field Results with Frozen Semen. *J. Animal Sci.*, **12**: 893. 1953.

(2) Dunn, H. O., Larson, G. L., and Willett, E. L. Preliminary Breeding Results with Frozen Semen. *J. Dairy Sci.*, **36**: 578. 1953.

(3) Dunn, H. O., Larson, G. L., and Willett, E. L. The Effects of Freezing Bovine Spermatozoa in Extenders Containing Antibacterial Agents. *J. Dairy Sci.*, **36**: 728. 1953.

(4) Holt, A. F. The Effect of Glycerolisation of Bull Semen on Fertility. *Vet Record*, **65**: 624. 1953.

(5) Holt, A. F. The Effect of Glycerolisation of Bull Semen on Fertility. II. *Vet Record*, **65**: 679. 1953.

(6) Macpherson, J. W., and Henderson, J. A. Low Temperature Preservation of Bull Semen. Paper presented at Convention of Am. Vet. Med. Assoc., Toronto, Canada. July 23, 1953.

(7) Miller, W. J., and VanDemark, N. L. Factors Affecting Survival of Bull Spermatozoa at Sub-Zero Temperatures. *J. Dairy Sci.*, **36**: 577. 1953.

(8) Polge, C., and Lovelock, J. E. Preservation of Bull Semen Stored at −79° C. *Vet. Record*, **64**: 396. 1952.

(9) Polge, C., and Rowson, L. E. A. Results with Bull Semen Stored at −79° C. *Vet. Record*, **64**: 851. 1952.

(10) Polge, C., Rowson, L. E. A., Stower, J., Holt, A. F., Bruce, W., Swanney, J. M., and Moss, J. A. The Storage of Bull Semen at Low Temperatures. *Vet. Record*, **65**: 557. 1953.

(11) Rowson, L. E. A., and Polge, C. Storage of Bull Semen at −79° C. and Fertility Results for Up to 12 Months. *Vet. Record*, **65**: 677. 1953.

(12) Snedecor, G. W. *Statistical Methods*. 4th ed. Iowa State College Press, Ames. 1946.

THE RELATIONSHIP BETWEEN FORAGE DRY MATTER DIGESTIBILITY AND WEIGHT GAIN BY DAIRY HEIFERS ON THREE WINTER GRAZING CROPS[1]

M. E. McCULLOUGH, D. M. BAIRD, AND O. E. SELL
Georgia Agricultural Experiment Station
Experiment, Georgia

Annually seeded winter forages have received considerable attention in recent years as a means of providing feed for milk production in the South. In general, such forage has proven superior to ordinary barn rations of hay and grain. The literature contains little information on the use of such forages for growing dairy heifers.

Oats is perhaps the most widely grown temporary crop for winter grazing; rye is also used very generally. Much interest has been shown in recent years in rescue grass for winter grazing. One objective of this experiment was to determine the dry matter digestibility and the weight gains made by dairy heifers on three winter grazing crops.

EXPERIMENTAL PROCEDURE

Three forages, Abruzzi rye, Arlington oats, and Chapel Hill rescue grass, were seeded September 22, 1953. Two 1-acre plots of each forage were planted at recommended seeding rates, and 400 lb. per acre of 4-8-6 fertilizer was drilled at seeding time. In addition, the forages were topdressed with 100 lb. of ammonium nitrate on October 14 and again on February 2. Because of a lack of rainfall during the autumn months, the forages were not available for grazing until January 4.

Seven Guernsey and two Jersey heifers were divided into three groups according to weight and were used in a 3 × 3 Latin square design during an 18-week trial divided into three 6-week periods.

The average weight of the heifers at the beginning of the experiment was 328 lb. To permit regrowth of the forages, the animals were shifted between replicates every 2 weeks. The animals received no feed in addition to the forage. A salt-mineral mixture was fed free choice throughout the experiment.

One-day weights were recorded at 14-day intervals. Fecal samples (grab) were collected at 14-day intervals for the determination of dry matter digestibility by the chromogen technique outlined by Reid *et al. (4)*. Coefficients of apparent digestibility of dry matter were calculated from fecal chromogen content with the formula suggested by Reid *et al. (4)*. Hand-clipped forage samples (clipped to a 1½ in. stubble height) were collected at intervals throughout the experiment, and "proximate" analysis was determined by A.O.A.C. methods *(1)*.

Received for publication June 22, 1954.

[1] Journal Series No. 267, Georgia Agricultural Experiment Station.

RESULTS AND DISCUSSSION

The chemical composition of hand-clipped samples of the three forages is shown in Table 1. The dates of sampling were mid-points in each of the three 6-week periods. In general, the values are typical of the change in composition of winter forages and need no explanation. The increase in crude protein will be discussed later.

TABLE 1

Chemical composition of the three forages by periods (dry matter basis)

Forage	Date	Crude protein	Ether extract	Crude fiber	N.F.E.	Ash
		(%)	*(%)*	*(%)*	*(%)*	*(%)*
Oats	1/19/54	19.00	4.29	14.15	54.24	8.31
	3/4/54	29.30	5.36	17.46	39.19	8.67
	4/14/54	14.91	3.27	22.28	51.64	7.88
Rye	1/19/54	22.73	5.40	13.77	50.60	7.47
	3/4/54	25.44	4.74	18.99	40.72	10.88
	4/14/54	16.89	3.76	28.19	45.21	5.94
Rescue	1/19/54	22.02	4.77	16.82	46.33	10.05
	3/4/54	25.44	5.14	18.17	40.40	10.29
	4/14/54	13.98	3.18	30.70	44.79	7.34

An analysis of variance of the average daily gains and dry matter digestibility by 14-day periods yielded statistically significant differences between periods only. The data for weight gains and digestibility by periods have been summarized in Table 2.

TABLE 2

Mean dry matter digestibility, mean average daily gain, and correlations between the two

Period	Forage	Mean		Correlation between dry matter dig. and daily gain
		Dry matter dig.	Daily gain	
		(%)	*(lb.)*	*(r)*
1	Oats	75.9	1.71	(all forages)
	Rye	75.8	1.22	
	Rescue	75.7	0.97	−0.011
2	Oats	75.9	2.12	
	Rye	76.8	1.97	
	Rescue	77.3	1.92	+0.304
3	Oats	70.0	1.92	
	Rye	68.1	1.74	
	Rescue	71.1	2.01	+0.512[a]

[a] Significant at the 1% level.

The average dry matter digestibility values show a remarkably small range and a remarkably high value throughout the experiment. Repeated observations of winter forages at this station have shown this as a dominant characteristic of winter forages. The generally low temperatures apparently serve to maintain

the forages in a leafy stage of growth throughout most of the winter grazing period. The first distinct signs of stem growth appeared about March 17 in the rye, but stems were not apparent on the oats and rescue until about April 1.

If dry matter digestibility is used as a criterion of forage feeding value, the small and nonsignificant correlations obtained between dry matter digestibility and average daily gains during Periods 1 and 2 would indicate that forage quality was not a limiting factor in weight gains until the forages began to mature in Period 3 (Table 2). These observations are similar to those made previously at this station with milking cows *(2, 3)*.

Weight gains on winter forage are somewhat difficult to explain. The average daily gains during Period 1 are lower than in either of the two other periods. Apparently part of the difficulty is due to climatic conditions. The sharp rise in weight gains in March corresponds to the beginning of warm spring days. This sudden rise in weight gains at this season is a regularly observed phenomenon in this area and to date has not been fully explained. The slight rise in crude fiber of the forage in the March 3 samples was accompanied by a decrease in the scouring usually associated with winter forage. Further work is necessary to establish the relationship, if any, between crude fiber, scouring, and weight gains of animals grazing winter pastures. The forage grazed during Period 1 should not have been deficient in protein, and the sharp decline in crude protein during Period 3 was not accompanied by a correspondingly sharp fall in weight gains.

It should be pointed out that the forage samples collected for chemical analysis were hand clipped to a uniform stubble height of about 1½ in. During Period 1 and to a considerable extent in Period 2 the animals grazed the three grasses fairly uniformly, and the chemical analysis of the hand clipped forage should be typical of the forage actually grazed. There was considerable selective grazing, however, in the last period so that chemical analysis of the hand clipped forage may not be typical of what the animals actually consumed.

Finally, it was of interest to observe the excellent rate of gain and growth of the heifers wintered on pasture alone. The animals gained an average of 218 lb. each during the 112-day trial. Although there were no significant differences between the average daily gains on the three forages, the fact that the heifers on oats averaged 242 lb. of weight gain and those on rescue and rye averaged 205 and 207 lb., respectively, may be of practical value in selecting the forage to be used. The heifers all finished the trial in excellent physical condition and were well developed for their age.

SUMMARY

Nine dairy heifers, averaging 328 lb. at the beginning of the experiment, were used in a 3 × 3 Latin square to study the relationship between dry matter digestibility of winter forages and weight gains. Three forages, Abruzzi rye, Arlington oats, and Chapel Hill rescue, were used in an 18-week trial divided into three 6-week periods. Dry matter digestibility was apparently not a limiting

factor until the forages began to mature in Period 3. Average dry matter digestibilities for the forages were: rye, 73.5%; oats, 73.9%; and rescue, 74.7%. Average daily gains of heifers were: on rye, 1.64 lb.; on oats, 1.91 lb.; and on rescue, 1.63 lb.

REFERENCES

(1) Association of Official Agricultural Chemists. *Official and Tentative Methods of Analysis.* 7th ed. 1950.

(2) McCullough, M. E. Factors Involved in Forage Quality for Dairy Cows. Georgia Agr. Expt. Sta., *Tech. Bull.* 3. 1953.

(3) McCullough, M. E., Neville, W. E., Jr., and Sell, O. E. The Suitability and Utilization of Winter Forages for Dairy Cattle. Georgia Agr. Expt. Sta., *Mimeo Series* 62. 1953.

(4) Reid, J. T., Woolfolk, P. G., Hardison, W. A., Martin, C. M., Breendoge, A. L., and Kaufmann, R. W. A Procedure for Measuring the Digestibility of Pasture Forage under Grazing Conditions. *J. Nutrition*, **46**: 255. 1952.

SEMEN PRODUCTION AND FERTILITY OF DAIRY BULLS EJACULATED EITHER ONCE OR TWICE AT INTERVALS OF EITHER FOUR OR EIGHT DAYS

R. W. BRATTON AND R. H. FOOTE
Department of Animal Husbandry, Cornell University, Ithaca, N. Y.

The increased usefulness of dairy sires through artificial breeding has come about primarily from increased extension rates of semen and improved extenders and processing procedures. Although there is still room for substantial improvement in each of these areas, it seems that further increases from these sources are likely to be rather small and costly to obtain.

In contrast to the above situation, little is known about the maximum number of spermatozoa that can be obtained from bulls, particularly over long periods of time, or what effects frequent ejaculation may have on fertility and subsequent spermatozoa production *(4, 9, 10, 11, 14, 15)*. Work by Collins *et al. (5)* and more recently by Branton *et al. (1)* and Hale *et al. (8)* suggests that many more spermatozoa may be obtained from bulls than has generally been thought to be possible.

Following the early work reported by Mercier *et al. (11)* a series of long-time experiments were undertaken by this laboratory in cooperation with the New York Artificial Breeders' Cooperative, Inc., to obtain information on the relationship of frequency of ejaculation to spermatozoa production and fertility. The results reported here are from a year-long experiment in which dairy bulls were ejaculated once at either 4- or 8-day intervals or twice at 8-day intervals.

EXPERIMENTAL PROCEDURE

Two groups of bulls each consisting of eight Holsteins, four Guernseys, three Jerseys, and two Ayrshires were selected from the active stud of the New York Artificial Breeders' Cooperative, Inc. One group was ejaculated once at 4-day intervals for 360 days and the other group was ejaculated once at 8-day intervals for 272 days and then twice at 8-day intervals for the remaining 88 days of the 360-day experimental period. At the time these experiments were begun (August, 1948), the studies on sexual excitement of bulls had not been made *(1, 5, 8)*; consequently, the bulls in this experiment were not restrained at the time semen was collected.

Feeding and other management practices of the bulls were those common to the stud at that time.

The volume of each ejaculate, the number of spermatozoa per milliliter of semen, and the per cent of motile spermatozoa in the ejaculates were determined by the routine procedures of this laboratory *(12, 16)*. Only the semen ejaculates containing 900×10^6 or more spermatozoa per milliliter of semen and 70% or more motile spermatozoa and having a methylene blue reduction time of 7 minutes or less were extended for breeding purposes. The semen was partially ex-

Received for publication June 24, 1954.

tended and cooled to 5° C. *(7)* and then made up to final volume with either 2.9% citrate–sulfanilamide yolk *(3, 13)* or experimental whole egg extenders *(6)*. The latter extenders were used for only the Holstein and Guernsey semen on a split-ejaculate basis to avoid confounding of these superimposed treatments with the collection regimes. The extenders contained no penicillin or streptomycin.

The semen extension rates varied, depending upon the day-to-day and seasonal demands for semen and the amount of semen produced by the individual bulls. During the last 88 days of the experiment the two ejaculates obtained from the 8-day interval bulls were mixed for processing and subsequent use in inseminating cows.

Breedings were made by the technicians affiliated with the New York Artificial Breeders' Cooperative, Inc., with semen which, on the average, was about 33 hours old. The extended semen of a particular ejaculate was shipped to as many field technicians as the available volume would permit. The next time this bull was ejaculated his semen was shipped to technicians not receiving it the time before. By rotating bulls among technicians in this manner all technicians received about equal opportunities to use each bull.

The average 60- to 90-day per cent nonreturns to first services for treatments were calculated on the basis of the average per cent nonreturns for the individual bulls, since the number of services for any particular bull was not a random variable but was, to a large extent, dependent upon his breed, his popularity and whether or not he was a young bull being sampled and held in waiting for an AB proof.

RESULTS AND DISCUSSION

In Table 1 are the group averages for the semen and fertility observations made during the two periods of the experiment. Of particular interest and importance in this table are the numbers of motile spermatozoa per ejaculate and per 8-day period and the per cent nonreturns to first services. During the first 272 days of the experiment the 4-day interval bulls averaged 5.7 billion motile spermatozoa per ejaculate and 11.4 billion per 8-day period, whereas the 8-day interval bulls averaged 7.0 billion motile spermatozoa per ejaculate and per 8-day period. Thus, per 8-day period, 63% more motile sperm were obtained from the 4-day than from the 8-day interval bulls.

When the 8-day interval bulls were changed from one ejaculate to two ejaculates every eighth day their motile sperm output per 8-day period was 101.6% of that for the 4-day interval bulls.

It might be reasoned that the 4-day interval between ejaculations or the collecting of two ejaculates every eighth day would result in an increased percentage of unusable ejaculates. However, it is now known that the basis for discarding ejaculates at the time this experiment was in progress was not justified *(2)* and, consequently, the estimates of the percentages of discarded ejaculates shown in Table I were determined on the basis of criteria used in present day operations. That is, an ejaculate was considered as unusable if it contained "many morphologically abnormal spermatozoa" or failed to meet any one of the following

TABLE 1

Semen and fertility data of bulls ejaculated either once or twice at either 4- or 8-day intervals

Criteria	Average values			
	First 272 days[a]		Last 88 days[a]	
	1 ejac. at 4-day interval	1 ejac. at 8-day interval	1 ejac. at 4-day interval	2 ejac. at 8-day interval[b]
No. of bulls	14	16	14	16
Ejac. discarded *(%)*	5.1	6.1	7.2	9.6
Vol. of ejac. *(ml.)*	5.7	6.5	6.3	6.3
Motile sperm *(%)*	68	67	67	67
10^9 total sperm/ml semen	1.48	1.63	1.49	1.51
10^9 motile sperm/ejac.	5.7	7.0	6.3	6.4
10^9 motile sperm/8 days	11.4	7.0	12.6	12.8
Total 1st services	30,163	25,187	10,187	11,692
60- to 90-day nonreturns to 1st services *(%)*	61.8	64.8	65.2	67.9

[a] Three bulls in the 4-day group and one in the 8-day group died for reasons not attributable to the experimental regimes.

[b] Average of 1st plus 2nd ejaculates.

minimum standards: 50% motile sperm, 500×10^6 total sperm per milliliter of fresh unextended semen, a motility rate of 2.0 *(2)*, $1{,}000 \times 10^6$ motile sperm per ejaculate. Because the bulls in this experiment were not restrained before allowing them to ejaculate, the percentages of discarded ejaculates do not appear excessive for any of the collection regimes. Furthermore, in terms of the per cent of motile spermatozoa output these discards amount to only a few wasted spermatozoa.

A comparison of the nonreturn rates when portions of ejaculates were extended in either yolk–citrate or whole egg extenders indicated that the per cent nonreturn averages for the two groups of bulls were not altered. Consequently, it was not necessary to delete the breedings made with semen extended in whole egg, and the fertility results reported here represent all breedings without regard to the kind of extenders used.

The average 60- to 90-day per cent nonreturns were slightly in favor of the 8-day interval bulls. The differences of 3.0 and 2.7 percentage units for the 272-day and 88-day experimental periods, respectively, were not statistically significant, $P < 0.05$. The among-bull mean square was used as experimental error, since bull difference did contribute to the sampling variance between treatments.

The trends in sperm output and fertility are of some interest in an experiment of 12 months duration. Figure 1 shows that for all practical purposes the trends for both motile sperm output and fertility were essentially constant throughout the 12 months of the experiment.

The fact that the 4-day interval bulls did not decrease in either sperm output or fertility during the latter months of the experiment raises the question of how long this particular frequency of ejaculation could be maintained. An answer must await results from studies lasting several years. It also raises the question of what is the shortest interval between ejaculations that is compatible with an output of maximum numbers of highly fertile spermatozoa during a

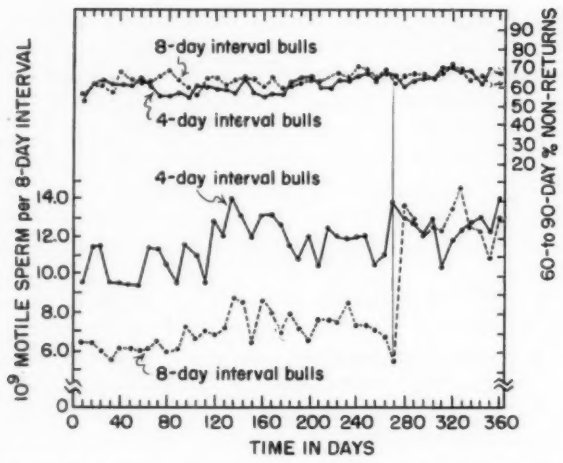

8-day interval bulls
4-day interval bulls
4-day interval bulls
8-day interval bulls
10^9 MOTILE SPERM per 8-DAY INTERVAL
60-to 90-DAY % NON-RETURNS
TIME IN DAYS
0 40 80 120 160 200 240 280 320 360
0 6.0 8.0 10.0 12.0 14.0
20 30 40 50 60 70 80 90

FIG. 1. Time trends in spermatozoa output and fertility of dairy bulls ejaculated either once or twice at intervals of either 4 or 8 days.

maximum length of time. Here, again, further research is needed. It is conceivable that an optimum relationship exists between these factors which, if known, would make possible the maximum rate of genetic improvement by balancing slightly lower fertility against increased selection intensity.

From this experiment it is concluded that a 4-day interval between single ejaculations or an 8-day interval between two ejaculations is not detrimental to semen production or fertility, and that approximately 60% more motile spermatozoa can be obtained per unit time by collecting either one ejaculate at 4-day intervals or two ejaculates at 8-day intervals instead of one ejaculate at 8-day intervals.

SUMMARY

A group of 14 dairy bulls ejaculated once at 4-day intervals for 272 days averaged 5.7 billion motile spermatozoa per ejaculate. Another group of 16 bulls ejaculated once at 8-day intervals for 272 days averaged 7.0 billion motile spermatozoa per ejaculate. The average 60- to 90-day per cent nonreturns to more than 25,000 first services per group was 61.8 for the 4-day bulls and 64.8 for the 8-day bulls, a difference that was not statistically significant, $P < 0.05$.

During an 88-day period immediately following the 272-day period the 8-day interval bulls were ejaculated twice every eighth day and averaged 5.7 billion motile spermatozoa per ejaculate and 12.8 billion per 8-day period. The 4-day interval bulls, continued on the original interval between ejaculates, averaged 12.6 billion motile spermatozoa on an 8-day basis during this same period. The 60- to 90-day per cent nonreturns to first services was 65.2 for the 4-day bulls and 67.9 for the 8-day bulls. Again, the difference was not statistically significant, $P < 0.05$.

It is concluded that one ejaculation every fourth day or two ejaculations every eighth day for periods as long as 1 year are not detrimental to semen production or fertility and that ejaculations at a rate of two per 8-day interval will yield about 60% more motile sperm than will ejaculations at the rate of one per 8-day interval.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the assistance of the management and the technicians of the New York Artificial Breeders' Cooperative, Inc., for furnishing the bulls; collecting, examining, and processing the semen; breeding the cows; and providing the fertility records for these studies. Acknowledgment is also due Mrs. Delma Muller and Mrs. Sally Shipman for summarizing many of the voluminous data collected during the course of the experiments and to C. R. Henderson for suggestions concerning statistical analysis of the data and preparation of the manuscript.

REFERENCES

(1) Branton, C., D'Arensbourg, G., and Johnston, J. E. Semen Production, Fructose Content of Semen and Fertility of Dairy Bulls as Related to Sexual Excitement. *J. Dairy Sci.*, **35**: 801. 1952.

(2) Bratton, R. W., and Foote, R. H. Unpublished data. Department of Animal Husbandry, Cornell University, Ithaca, N. Y.

(3) Bratton, R. W., Foote, R. H., Musgrave, S. D., and VanDemark, N. L. Livability and Fertility of Bovine Spermatozoa in Different Diluents. *J. Dairy Sci.*, **32**: 604. 1949.

(4) Burch, G. E. Artificial Insemination in New York State Dairy Herds. *Cornell Vet.*, **29**: 395. 1939.

(5) Collins, W. J., Bratton, R. W., and Henderson, C. R. The Relationship of Semen Production to Sexual Excitement of Dairy Bulls. *J. Dairy Sci.*, **34**: 224. 1951.

(6) Dunn, H. O., Bratton, R. W., and Collins, W. J. Fertility and Motility of Bovine Spermatozoa in Buffered Whole-Egg Extenders. *J. Dairy Sci.*, **33**: 434. 1950.

(7) Foote, R. H., and Bratton, R. W. The Fertility of Bovine Semen Cooled with and without the Addition of Citrate–Sulfanilamide–Yolk Extender. *J. Dairy Sci.*, **32**: 856. 1949.

(8) Hale, E. B., Almquist, J. O., and Thacker, D. L. Observations on the Sexual Behavior and Semen Production of Dairy Bulls. (Abs.) *J. Dairy Sci.*, **36**: 576. 1953.

(9) Kirillov, V. S., and Morozov, V. A. The Influence of Sexual Activity of Bulls on Their Reproductive Ability (Trans. title). *Problemy Zhivotnovodstva*, **5**: 90. 1933. (Abs.) *Animal Breeding Abstr.*, **1**: 237. 1934.

(10) Lasley, J. F., and Bogart, R. Some Factors Influencing Reproductive Efficiency of Range Cattle under Artificial and Natural Breeding Conditions. Mo. Agr. Expt. Sta., *Research Bull.* **376**: 1943.

(11) Mercier, E., Bratton, R. W., and Salisbury, G. W. Semen Production and Fertility of Dairy Bulls as Related to Frequency of Ejaculation. *Cornell Vet.*, **39**: 32. 1949.

(12) Salisbury, G. W., Beck, G. H., Elliott, I., and Willett, E. L. Rapid Methods for Estimating the Number of Spermatozoa in Bull Semen. *J. Dairy Sci.*, **26**: 69. 1943.

(13) Salisbury, G. W., Knodt, C. B., and Bratton, R. W. The Freezing Point Depression of Bull Semen and Its Relation to the Diluter Problem. *J. Animal Sci.*, **7**: 283. 1948.

(14) Trimberger, G. W. Present-Day Techniques of Artificial Insemination. *J. Dairy Sci.*, **25**: 671. 1942.

(15) Weatherby, E. T., Reece, R. P., and Bartlett, J. W. The Ability of Dairy Bulls to Withstand Regular Services for Artificial Insemination During One Year. *Proc. Am. Soc. Animal Production*, 33rd Ann. Meet. p. 224. 1940.

(16) Willett, E. L., and Salisbury, G. W. The Effect of Various Diluters, Cooling Rate, Temperature of Storage, and Some Other Factors on the Livability of Spermatozoa in Stored Samples of Bull Semen. Cornell (N. Y.) Agr. Expt. Sta., *Memoir* 259. 1942.

SEMEN PRODUCTION AND FERTILITY OF MATURE DAIRY BULLS EJACULATED EITHER ONCE OR TWICE AT 8-DAY INTERVALS

R. W. BRATTON, R. H. FOOTE, AND C. R. HENDERSON
Department of Animal Husbandry, Cornell University, Ithaca, N. Y.

In a previous report from this laboratory it was shown that bulls ejaculated either once at 4-day intervals or twice at 8-day intervals yielded approximately 60% more motile spermatozoa per unit time than when ejaculated only once at 8-day intervals *(2)*. However, those bulls were not restrained to any extent in order to induce a high level of sexual excitement before ejaculation, a procedure which has since been demonstrated by Collins *et al. (5)*, Branton *et al. (1)*, and Hale *et al. (8)* to effect a substantial increase in spermatozoa output. Therefore, another year-long experiment was started in August, 1952, to determine whether or not results similar to those previously reported *(2)* would be obtained when bulls were subjected to planned amounts of restraint as described by Collins *et al. (5)*.

EXPERIMENTAL PROCEDURE

Two groups of seven Holstein bulls were selected from the active stud of the New York Artificial Breeders' Cooperative, Inc. The bulls were paired on the basis of their previous fertility level and then the individuals within pairs were randomized to two groups. The groups in turn were randomized to treatments. On the basis of this randomization the average motile spermatozoa output per ejaculate during the 12 months prior to the experiment was essentially the same, 10.6 billion for the one-ejaculate group and 11.1 billion for the two-ejaculate group. To avoid using the same bull on the same day each week, an 8-day interval between ejaculations was established. Since it was anticipated that during the heavy breeding season some bulls would not furnish enough spermatozoa to make them available to all technicians on a particular day, the technicians were divided into two groups. By so doing, any one ejaculate would then meet the daily requirements of any one technician group.

To minimize confounding of technician groups with treatment groups all bulls were alternated between groups regularly, both as regards the treatment group they were in and as regards the first and second ejaculates.

For the one-ejaculate bulls the procedure for inducing sexual excitement consisted of allowing them to mount or attempt to mount a teaser cow or bull for at least 20 minutes. At the end of this time it was generally found that bulls were difficult to restrain so they were allowed to mount and ejaculate. Occasionally a bull required more than this standard amount of time. The same procedure was followed for the first ejaculate from the two-ejaculate bulls. After the first ejaculate was obtained, a 10-minute rest period was allowed, followed by a 10-minute teasing period. The second ejaculate then was obtained usually without delay.

Received for publication June 24, 1954.

The volume, the per cent of motile spermatozoa *(11)*, and the number of motile spermatozoa per milliliter of semen *(9)* were determined for each ejaculate. The semen was pre-extended in 2.9% citrate–sulfa–yolk *(4, 10)* containing 500 units each of penicillin and streptomycin and cooled and processed according to the standard procedure employed by the New York Artificial Breeders' Cooperative, Inc. *(7)*. The final extension of the semen provided 10×10^6 motile spermatozoa per milliliter of extended semen at the time of shipping *(7)*. The fertility of each ejaculate was based on the 60- to 90-day per cent nonreturns to first service cows bred by technicians affiliated with the New York Artificial Breeders' Cooperative, Inc.

RESULTS AND DISCUSSION

Because of unexpected mortalities and injuries, two pairs of bulls were lost from the experiment, leaving five in each group as the basis of the data reported here. The semen data and fertility results are shown in Table 1. Of particular interest is the similarity in average number of motile spermatozoa in the first ejaculates, 10.6 billion for the one-ejaculate bulls and 10.3 billion for the two-ejaculate bulls. The 6.9 billion motile spermatozoa in the second ejaculates made a total of 17.2 billion per 8-day period for the two-ejaculate bulls. This represents an increase of 62% over the one-ejaculate bulls and is comparable to the 63% increase previously reported *(2)* for the total of two-ejaculates when each was taken at 4-day intervals versus a single ejaculate taken at an 8-day interval. This is a remarkable degree of agreement in view of the fact that four groups of bulls, two different times, and two semen collection procedures were involved.

The average fertility of the two groups was almost identical. This can be seen in Table 1 and Figure 1. There was no downward trend with time in either motile spermatozoa output or fertility. Again the findings are similar to those previously reported *(2)*.

TABLE 1

Semen data and fertility results for bulls ejaculated either once or twice at 8-day intervals during a 360-day experimental period

Criteria		Group averages		
		1 ejac. bulls	2 ejac. bulls	
			1st ejac.	2nd ejac.
Number of bulls per group		5		5
Ejaculates discarded	*(%)*	2.3[a]	0.0	2.3[b]
Volume of semen per ejac.	*(ml.)*	10.4	8.9	8.6
Motile sperm	*(%)*	63.5	66.9	67.2
Number of sperm per ml. semen	$\times 10^9$	1.64	1.72	1.20
Number of motile sperm per ejaculate	$\times 10^9$	10.6	10.3	6.9
Number of motile sperm per unit time (8 days)	$\times 10^9$	10.7		17.2[c]
First services (total all bulls)		40,587	27,874	23,741
60- to 90-day nonreturns to 1st services	*(%)*	73.3	73.6	73.4

[a] This is equal to a loss of 1.6% of the motile sperm output per ejaculate.

[b] This is equal to a loss of 0.8% of the motile sperm output per ejaculate.

[c] First plus second ejaculates.

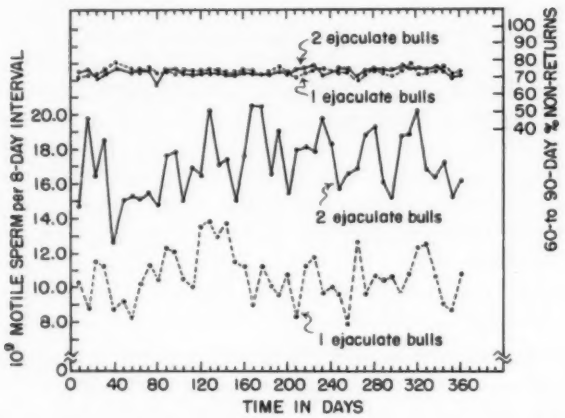

2 ejaculate bulls
1 ejaculate bulls
2 ejaculate bulls
1 ejaculate bulls
10⁹ MOTILE SPERM per 8-DAY INTERVAL
60-to 90-DAY % NON-RETURNS
TIME IN DAYS
0 40 80 120 160 200 240 280 320 360
20.0 18.0 16.0 14.0 12.0 10.0 8.0 0
100 90 80 70 60 50 40

FIG. 1. Time trends in spermatozoa output and fertility of dairy bulls ejaculated either once or twice at 8-day intervals.

Of the total of 775 possible ejaculates from the ten bulls, 12 were lost at the time of collection, five contained less than 500×10^6 spermatozoa per milliliter of semen, and five had less than 50% motile spermatozoa, which is an extremely small percentage loss of ejaculates.

The use of these findings as a tool for improving the genetic merit of a population of dairy cows for milk and butterfat production is probably most easily visualized by considering the potential numbers of artificial breedings of which the ten bulls in this experiment were capable. On an operational basis of two ejaculates at 8-day intervals, the estimated yearly output of spermatozoa per bull would be:

17.2×10^9	total motile sperm per ejaculate
$- \quad 1.2 \times 10^9$	motile sperm per ejaculate in processing losses
16.0×10^9	motile sperm per ejaculate available for extending
$\times \ 45.6$	collections per year
$730 \quad \times 10^9$	motile sperm per year

If an extension rate resulting in 10×10^6 motile spermatozoa per milliliter of extended semen were used, the potential number of breedings per sire per year would be:

$$\frac{730 \times 10^9}{10 \times 10^6} = 73{,}000$$

With an estimated calving rate of approximately 56% *(6)* for all services, the potential number of progeny per sire is $73{,}000 \times 0.56$, or 40,880. Thus the ten bulls in this experiment demonstrated a potential of nearly three-quarters of a million services and a quarter of a million female progeny per year. At the

present time it is estimated that at least 50% of this potential may be achieved.

If, in the future, frozen semen should replace the present methods of preserving semen, and if other research should make possible the use of fewer spermatozoa per breeding, the potential number of progeny per sire per year could be considerably greater than 40,880. Obviously, these studies indicate that far fewer bulls are needed than are now used to breed the population of cows presently enrolled for artificial breeding.

Over and above the direct monetary savings to be achieved by using fewer bulls, probably the most important implication of the results of these studies is that methods for the genetic appraisal and selection of sires must be more reliable as the number of sires necessary to breed a particular cow population decreases. Otherwise, the risk of unwittingly using a sire of undesirable genetic merit would seem to preclude attaining the potentials indicated by these studies.

SUMMARY AND CONCLUSIONS

A group of five Holstein bulls ejaculated once at 8-day intervals for 360 days averaged 10.6 billion motile spermatozoa per ejaculate. In another comparable group ejaculated twice at 8-day intervals during the same period of time the first ejaculates averaged 10.3 billion and the second ejaculates 6.9 billion motile spermatozoa per ejaculate. The average 60- to 90-day per cent nonreturns to first-service cows was 73.3 for the one-ejaculate bulls and 73.6 for the first ejaculates and 73.4 for the second ejaculates from the two-ejaculate bulls.

It was estimated that on the basis of the spermatozoa output of the two-ejaculate bulls the ten bulls in the experiment had a breeding potential under present day operational procedures of nearly three-quarters of a million services and nearly a quarter of a million female progeny. Such potentials emphasize the need for applying the best methods now available for testing and selecting the sires to be used so heavily.

ACKNOWLEDGMENTS

The authors wish to acknowledge the assistance of the management and technicians of the New York Artificial Breeders' Cooperative, Inc., for furnishing the bulls, collecting and processing the semen, breeding the cows, and providing the fertility records for this experiment.

Acknowledgment is also due to Mrs. Sally Shipman, Miss Kay Shipman, and Miss Joan Cruthers for summarizing many of the voluminous data collected during the course of the experiment.

REFERENCES

(1) Branton, C., D'Arensbourg, G., and Johnston, J. E. Semen Production, Fructose Content of Semen and Fertility of Dairy Bulls as Related to Sexual Excitement. *J. Dairy Sci.*, **35**: 801. 1952.

(2) Bratton, R. W., and Foote, R. H. Semen Production and Fertility of Dairy Bulls Ejaculated Either Once or Twice at Intervals of Either Four or Eight Days. *J. Dairy Sci.*, **37**: 1439. 1954.

(3) Bratton, R. W., Foote, R. H., and Henderson, C. R. The Relationship Between Fertility and the Number of Spermatozoa Inseminated. *J. Dairy Sci.*, **37**: 1353. 1954.

(4) Bratton, R. W., Foote, R. H., Musgrave, S. D., and VanDemark, N. L. Livability and Fertility of Bovine Spermatozoa in Different Diluents. *J. Dairy Sci.*, **32**: 604. 1949.

(5) Collins, W. J., Bratton, R. W., and Henderson, C. R. The Relationship of Semen Production to Sexual Excitement of Dairy Bulls. *J. Dairy Sci.*, **34**: 224. 1951.

(6) Foote, R. H. Unpublished data. Department of Animal Husbandry, Cornell University, Ithaca, N. Y.

(7) Foote, R. H., and Bratton, R. W. The Fertility of Bovine Semen Cooled with and without the Addition of Citrate–Sulfanilamide–Yolk Extender. *J. Dairy Sci.*, **32**: 856. 1949.

(8) Hale, E. B., Almquist, J. O., and Thacker, D. L. Observations on the Sexual Behavior and Semen Production of Dairy Bulls. (Abs.) *J. Dairy Sci.*, **36**: 576. 1953.

(9) Salisbury, G. W., Beck, G. H., Elliott, I., and Willett, E. L. Rapid Methods for Estimating the Number of Spermatozoa in Bull Semen. *J. Dairy Sci.*, **26**: 69. 1943.

(10) Salisbury, G. W., Knodt, C. B., and Bratton, R. W. The Freezing Point Depression of Bull Semen and Its Relation to the Diluter Problem. *J. Animal Sci.*, **7**: 283. 1948.

(11) Willett, E. L., and Salisbury, G. W. The Effect of Various Diluters, Cooling Rate, Temperature of Storage, and Some Other Factors on the Livability of Spermatozoa in Stored Samples of Bull Semen. Cornell (N. Y.) Agr. Expt. Sta., *Memoir* 249. 1942.

THE RELEASE OF AMMONIA NITROGEN FROM UREA, AMMONIATED MOLASSES, AND SOYBEAN OIL MEAL IN THE PRESENCE OF RUMEN MICROORGANISMS[1,2]

O. T. STALLCUP

Department of Animal Industry and Veterinary Science
Arkansas Agricultural Experiment Station
Fayetteville

The hypothesis that nonprotein nitrogen might be converted to protein by the rumen microflora and that the protein might be subsequently digested and utilized was first outlined more than a half century ago *(7, 29)*. The use of urea as a protein replacement has been reviewed recently by Reid *(20)*. Nitrogen metabolism in the rumen has been reviewed by McNaught and Smith *(13)*.

The levels of ammonia and crude protein in the rumen contents at intervals after feeding rations with and without urea were determined in a series of investigations at the University of Wisconsin *(16, 25, 26, 27)*. These workers reported that ammonia nitrogen was released rapidly from urea in the rumen, reaching its peak at 1 hour in most cases. A peak in ammonia nitrogen in the rumen contents was reached at 3 hours under certain feeding practices *(16)*. The fact that the contents of the rumen are part of a constantly changing system and that they are exceedingly heterogeneous and therefore difficult to sample accurately for chemical analyses prompted Pearson and Smith *(17)* to elaborate what is now known as the artificial rumen technique. These workers observed that the urease activity of the rumen ingesta was very great at all times of the day, whatever the time of feeding, and remained so little affected by relatively large amounts of urea that all the urea ever likely to be fed to even a high yielding cow in full lactation would be converted to ammonia within an hour after entering the rumen. Very rapid hydrolysis of urea was also observed by Lenkeit and Becker *(11)* and by Wegner *et al. (26)*. In further experiments, Pearson and Smith *(18)* observed that protein synthesis from ammonia and protein breakdown with the production of ammonia appeared to proceed at the same time in rumen contents but that synthesis exceeded breakdown when starch, maltose, or another simple sugar was present. The influence of protein *(3)*, sources of energy *(1)*, and minerals *(4)* on urea utilization in an artificial rumen have been reported.

Dairymen are interested in ammonia release not only from the viewpoint of availability of nitrogen in a form usable by the microflora but also because of the danger of toxicosis observed in cattle when high levels of urea are fed *(5, 6, 8,*

Received for publication June 25, 1954.

[1] This investigation was supported in part by a grant provided by the Commercial Solvents Corporation, Terre Haute, Indiana.

[2] Research Paper No. 1145, Journal Series, University of Arkansas. Published with the approval of the Director of the Arkansas Agricultural Experiment Station.

20, 28). Recently, ammoniated molasses and other ammoniated products have been utilized in the rations of ruminants with favorable results *(9, 10, 12, 14, 15, 22, 23)*. The relative release of ammonia, if any, from these products in the presence of rumen microflora has not been determined. It has been shown that several of our common feed stuffs, including dehydrated alfalfa, sun-cured alfalfa, cottonseed meal, linseed meal, pulverized oats, oat meal, soybean oil meal, and wheat mill products *(19)*, contain ammonia nitrogen. The possible release of this ammonia nitrogen in the presence of rumen microflora has not been studied.

The work reported herein was undertaken to determine the relative release of ammonia nitrogen from urea, ammoniated molasses, and soybean oil meal, in the presence of rumen microflora both in the rumen and in an artificial rumen.

EXPERIMENTAL METHODS

The artificial rumen technique used in these investigations was similar to that described by Arias *et al. (1)*. Four artificial rumens were studied simultaneously. They consisted of four wide-mouthed Erlenmeyer flasks of 500-ml. capacity suspended by means of an adjustable shelf in a glass-chambered water bath maintained at 40° C. Each flask was closed with a two-hole rubber stopper. Each of these holes was fitted with rubber tubing so that a common supply of carbon dioxide gas could be passed through each of the four flasks and thus provide anaerobic conditions. The gas in the tubing leading away from each flask was bubbled through 1 *N* hydrochloric acid to trap any ammonia that might be given off and carried out by the stream of carbon dioxide. The flasks of the artificial rumen were charged with rumen liquor taken directly from the rumen before the morning feeding of a fistulated steer subsisting on a ration of all Korean lespedeza hay. Rumen contents were strained through two thicknesses of a No. 50 grade cheesecloth, care being taken to keep the liquid warm and not unduly aerated. This liquid containing rumen microorganisms was introduced into the flasks in 200-ml. amounts, which constituted 50% of the total fermentation volume.

To three of the flasks were added urea, ammoniated cane molasses (15.4% protein equivalent), and ammoniated invert molasses (33.3% protein equivalent), respectively, in such amounts that they were of equal nitrogen content. A fourth flask contained no added nitrogenous compounds and served as a control. To all flasks was added a complex mineral mixture whose composition is shown in Table 1. The exact contents of the flasks are as outlined in Table 2.

TABLE 1

Mineral solution resembling concentrated saliva

Sodium phosphate, monobasic *(g.)*	26.25
Sodium bicarbonate *(g.)*	26.25
Potassium chloride *(g.)*	3.75
Sodium chloride *(g.)*	3.75
Magnesium sulfate *(g.)*	1.13
Calcium chloride *(g.)*	0.38
Distilled water *(ml.)*	1,000.00

TABLE 2

Composition of the contents of the artificial rumens used in the in vitro fermentation studies

Component	Flask No. 1	2	3	4
Rumen liquor	200	200	200	200
Distilled water	169	169	169	169
Complex mineral mixture	31	31	31	31
Urea	400 mg.			
Ammoniated cane molasses (15.4% protein equivalent)		6.812 g.		
Ammoniated invert molasses (53.3% protein equivalent)			3.144 g.	

As soon as the materials were added to each flask, the contents were thoroughly mixed and a 25-ml. sample was withdrawn for analysis of free ammonia. This was designated as the 0-hour sample. Initially the flasks were sampled at 3-hour intervals, but, since this time interval did not indicate the short interval trend of release, this sampling process was repeated each hour until the sixth hour, at which time the process was halted. A 6-hour duration of the fermentation process was deemed sufficient, since Pearson and Smith *(17)* had demonstrated that all the urea likely to be fed a cow would be converted to ammonia within an hour after coming in contact with rumen microorganisms. The free ammonia of the artificial rumen contents was determined by a magnesium distillation procedure *(2)*.

In a second series of experiments, the release of ammonia from soybean oil meal (44% protein equivalent) was compared to the two samples of ammoniated invert molasses. The artificial rumens containing the ammoniated molasses and the control mixture were set up exactly as described in Table 1. A fourth flask contained 200 ml. of rumen liquor, 169 ml. of distilled water, 31 ml. of the complex salt mixture, and 2.382 g. of soybean oil meal. The amounts of the two samples of ammoniated molasses and of soybean oil meal were adjusted to the same nitrogen content. The sampling procedure, methods used, and duration of fermentation were as described for the preceding series of experiments.

In order to determine whether urease was capable of effecting the release of ammonia from the ammoniated molasses, it was decided to run a series of trials in which these materials were incubated in the presence of the enzyme.

Solutions for this trial were made up so that there were 100 mg. of urea, 595 mg. of soybean oil meal, 1,703 mg. of ammoniated cane molasses (15.4% protein equivalent), and 786 mg. of ammoniated invert molasses (33.3% protein equivalent), respectively, in 100 ml., each solution being brought up to volume with distilled water. To 25 ml. of each of the solutions was added five 25-mg. pellets of urease (Dunning) in a small beaker. Another 25 ml. of each solution to which no urease was added served as a control. All samples were incubated in a water bath at 40° C. for 1 hour. Each sample was then transferred to a Kjeldahl flask for magnesium oxide distillation *(2)* to determine the amount of free ammonia nitrogen present.

In order to obtain a clear understanding of ammonia release from these

materials in the rumen of the steer, it was decided to feed these substances to an animal possessing a rumen fistula and measure the level of free ammonia in the rumen liquor.

A 3-year-old Holstein steer, fitted with a plastic rumen fistula plug, was used in the investigation. The steer received a ration of 15 lb. of U. S. No. 2 Korean lespedeza hay daily. Dicalcium phosphate and salt (equal parts) and water were available at all times.

Initially, samples were taken when the steer received only the lespedeza hay. This trial represented a control which would reveal the approximate level of free ammonia released when hay alone was fed. The steer was placed on the diet for 15 days, being fed once daily. The steer was fed at approximately 9:00 A.M., allowed to eat at will, hay being usually consumed in 3 hours. The following morning before feeding, grab samples were taken of rumen contents. Care was taken to secure three portions of approximately 250 ml. each, from the top, middle, and lower levels of the rumen. These ingesta were composited and then squeezed through two thicknesses of No. 50 grade cheesecloth. A 25-ml. aliquot of the resulting rumen liquor was used for determination of free ammonia nitrogen. This sample was designated as the 0-hour sample. The animal was then fed and samples were taken 1, 2, 3, 6, 9, and 12 hours later. Following another conditioning period of 2 weeks, a 0-hour sample was taken and then 68 g. of urea was placed directly in the rumen. Care was taken to spread the urea uniformly over the exposed surface of the rumen contents. The 68 g. used represented approximately 1% of the total diet, which is generally considered a safe level of feeding. The animal was then fed 15 lb. of lespedeza hay, and samples were secured at intervals and in the manner described for the control trial.

Following another adjustment period of 2 weeks, in which only lespedeza hay was fed, another trial was conducted in which 535 g. of ammoniated invert molasses (33.3% protein equivalent) was placed in the rumen prior to feeding lespedeza hay. This amount was chosen so that the total nitrogen added to the rumen would be equal to that in the 68 g. of urea used in the previous trial. The procedures used were the same as in previous trials.

Another trial, in which 1,157 g. of ammoniated cane molasses (15.4% protein equivalent) was placed in the rumen, was conducted after a 2-week adjustment period. Again, the amount of nitrogen added in the ammoniated molasses was equal to that added as urea in the previous trial. The procedures used were as previously described.

Statistical methods used in this investigation were as outlined by Snedecor *(21)*.

RESULTS AND DISCUSSION

The data pertaining to the release of ammonia from urea and two samples of ammoniated molasses of varying nitrogen content are presented in Table 3 and Figure 1. Higher amounts of free ammonia were apparent in the artificial rumen solutions containing urea and the two samples of ammoniated molasses in the 0-hour sample than in the control. Thus it appears that some ammonia is

TABLE 3

The release of ammonia from urea and ammoniated molasses in the presence of rumen microorganisms in vitro (Data expressed as mg. NH_3-N/25 ml.)

Flask description	Hours of fermentation 0	1	2	3	4	5	6
				Urea			
Series 4	1.68	5.63	8.53	9.70	10.30	10.25	10.89
Series 5	2.39	7.66	9.72	10.36	10.26	10.68	10.42
Series 6	2.36	9.69	9.90	9.67	8.72	8.46	9.90
Av.	2.14	7.66	9.38	9.91	9.76	9.80	10.40
				Ammoniated invert molasses (33.3% protein equivalent)			
Series 4	1.834	1.932	1.951	1.974	2.044	2.703	2.352
Series 5	2.184	2.128	2.156	2.212	2.310	2.422	1.960
Series 6	1.680	1.764	1.834	1.792	1.708	1.666	1.806
Av.	1.899	1.941	1.980	1.993	2.021	2.265	2.039
				Ammoniated cane molasses (15.4% protein equivalent)			
Series 4	2.226	1.918	1.950	1.946	1.302	1.064	1.120
Series 5	2.324	2.380	1.946	1.708	1.414	1.148	0.784
Series 6	2.198	2.030	1.970	1.526	0.966	0.828	0.770
Av.	2.249	2.109	1.952	1.727	1.227	1.031	0.871
				Control flask			
Series 4	0.798	1.246	1.152	0.952	1.386	1.498	1.624
Series 5	0.966	1.064	1.162	1.330	1.358	1.568	1.974
Series 6	0.546	0.602	0.756	0.868	0.700	0.812	0.882
Av.	0.770	0.971	1.023	1.040	1.148	1.293	1.493

free when these substances are in solution and without prolonged urease action. The release of ammonia nitrogen from urea was high within 1 hour and gradually increased until a peak was reached at 3 hours. The amount of free ammonia nitrogen remained at a high level for 6 hours. These results are similar to those reported by Pearson and Smith *(18)* except that the peak of release was not reached so quickly.

There was a slight increase with each succeeding hour in ammonia nitrogen in the solution containing the ammoniated molasses of highest nitrogen content (33.3% protein equivalent). This increase may have been due to the rumen liquor present in the solution, as the control showed a similar increase when no other nitrogenous materials were present.

The ammonia nitrogen content of the solution containing the ammoniated molasses of 15.4% protein equivalent showed a consistent decrease with each succeeding hour. This was presumably due to the utilization of the nitrogen by the microorganisms. This is logical to assume, since much more potential energy was present in this solution than in either of the other solutions. No free ammonia escaped from the fermenting material as checked by the traps through which the stream of carbon dioxide passed after having passed over the fermenting material. This is in accord with the observation of Arias *et al. (1)* and is in agreement with the work of Washburn and Brody *(24)*, who did not list ammonia as one of the important rumen gases.

In the second series of fermentations in the artificial rumen, the release of ammonia nitrogen from soybean oil meal (44% crude protein) and the two

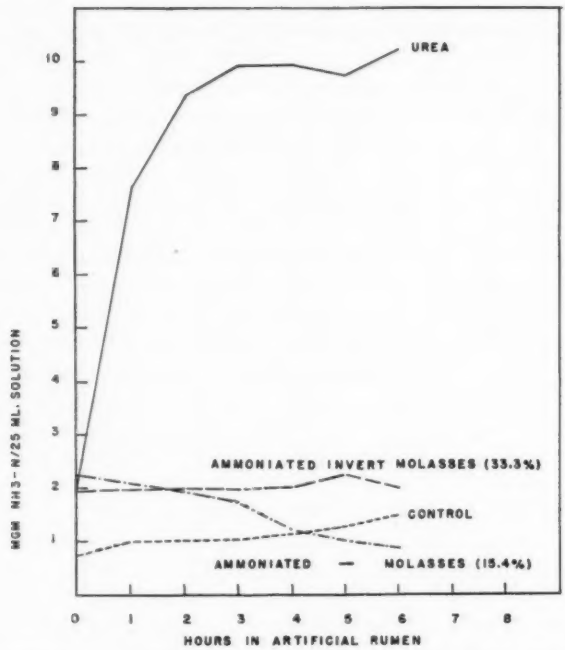

UREA
AMMONIATED INVERT MOLASSES (33.3%)
CONTROL
AMMONIATED — MOLASSES (15.4%)
MGM NH3-N/25 ML. SOLUTION
HOURS IN ARTIFICIAL RUMEN
0 1 2 3 4 5 6 7 8
1 2 3 4 5 6 7 8 9 10

FIG. 1. The release of ammonia nitrogen from urea and ammoniated molasses in an artificial rumen.

ammoniated molasses was studied. The data are presented in Table 4 and Figure 2. The release of ammonia nitrogen in the flask containing the soybean oil meal approximated that in the control flask. The free ammonia nitrogen in the invert molasses of 33.3% protein equivalent was higher than that in the control at the beginning of the incubation period and remained higher throughout the 6-hour period. The free ammonia nitrogen in the flask containing ammoniated molasses of 15.4% protein equivalent was higher than that of the control and approximately the same as that of the other ammoniated molasses. As the fermentation progressed, the ammonia nitrogen decreased until it approximated the level of the control by the end of the fifth hour. This phenomenon was as observed in the preceding series of fermentations, and again the logical explanation is that the higher energy furnished by the molasses stimulated greater microbial activity and consequent ammonia utilization. Again it appears that there is some ammonia nitrogen free in both of these ammoniated molasses, but it does not appear that urease of the rumen liquor is responsible for any appreciable release of ammonia from them.

The data relative to the release of free ammonia from urea, ammoniated molasses, and soybean oil meal in the presence of the enzyme urease are presented in Table 5.

TABLE 4

The release of ammonia from soybean oil meal (44% crude protein) and ammoniated molasses in the presence of rumen microorganisms in vitro (Data expressed as mg. NH_3-N/24 ml.)

Flask description	Hours of fermentation 0	1	2	3	4	5	6
				Soybean oil meal			
Series 1	1.680	1.708	1.932	2.254	2.408	2.422	2.415
Series 2	0.280	0.280	0.266	0.182	0.244	0.210	0.196
Series 3	0.784	0.798	1.022	1.078	1.134	1.092	1.316
Av.	0.914	0.929	1.073	1.171	1.244	1.241	1.309
				Ammoniated cane molasses (15.4% protein equivalent)			
Series 1	2.028	2.982	2.730	2.478	2.436	1.918	1.862
Series 2	1.964	1.470	1.148	0.910	0.700	0.616	0.630
Series 3	2.156	2.156	1.694	1.526	1.596	1.330	1.274
Av.	2.316	2.203	1.856	1.638	1.577	1.288	1.255
				Ammoniated invert molasses (33.3% protein equivalent)			
Series 1	2.800	2.562	2.758	3.388	2.912	2.814	2.982
Series 2	1.512	1.246	1.050	1.064	1.092	1.078	1.064
Series 3	1.974	1.904	1.792	1.960	2.198	2.380	2.366
Av.	2.095	1.004	1.867	2.137	2.067	2.091	2.137
				Control flask			
Series 1	1.526	1.512	1.778	1.848	1.988	2.128	2.184
Series 2	0.226	0.196	0.168	0.196	0.140	0.154	0.182
Series 3	0.770	0.812	1.092	1.106	1.376	1.484	1.582
Av.	0.841	0.840	1.013	1.050	1.168	1.255	1.316

An analysis of variance of these data (Table 6) indicates that the difference between replications of the same treatment was not significant. The action of urease appears to be highly significant and the difference in free ammonia is highly significant ($P < 0.01$) when these nutrient materials are exposed to urease for 1 hour. The difference in free ammonia between nutrient materials is significant ($P < 0.05$) when these materials are not exposed to urease. Further statistical analyses were made by subjecting the data for each nutrient material to "Student's" method of analysis for determination of significance of mean

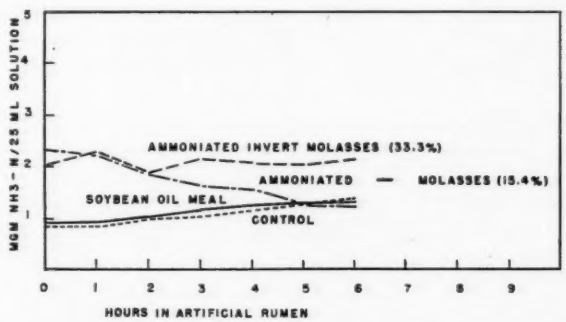


FIG. 2. The release of ammonia nitrogen from soybean oil meal and ammoniated molasses in an artificial rumen.

TABLE 5

The release of ammonia nitrogen in the presence of the enzyme urease (All values expressed as mg. NH_3-N/25 ml. solution)

Soybean oil meal		Ammoniated molasses (15.4%)		Urea		Ammoniated invert molasses (33.3%)	
Control	Urease added	Control	Urease added	Control	Urease added	Control	Urease added
0.056	0.210	1.498	1.470	0.077	9.100	1.159	1.190
0.060	0.294	1.512	1.596	0.070	7.574	1.152	1.372
0.054	0.244	1.624	1.610	0.357	6.636	1.183	1.400
0.056	0.224	1.624	1.596	0.350	7.161	1.176	1.386
0.075	0.280	1.120	1.582	0.182	7.112	1.260	1.400
0.070	0.266	1.134	1.652	0.168	7.043	1.274	1.386
Av. 0.062	0.250	1.419	1.584	0.201	7.438	1.201	1.356

difference. This was done to determine whether the differences in values of the samples incubated with urease for 1 hour as compared to those incubated without urease were significant. Significant differences ($P < 0.01$) were found with urea and soybean oil meal but not with either of the ammoniated molasses. Thus it would appear from these observations that the presence of urease is not associated with the release of free ammonia nitrogen from the ammoniated molasses used in this study. It is evident that urease is capable of effecting the release of free ammonia nitrogen from soybean oil meal and urea under the conditions of this experiment. The fact that urease is capable of liberating ammonia from urea is, of course, well known *(17)*. The control values for soybean oil meal and urea in Table 5 are lower than the 1-hour values for these substances in Tables 4 and 5, respectively. This is apparently due to the presence of ammonia nitrogen in the rumen liquor added to the artificial rumens, since no exogenous source of ammonia nitrogen was added to the beakers in which urease and the nutrient materials were incubated.

The data relative to the level of free ammonia nitrogen in the rumen liquor when urea and ammoniated molasses were placed in the rumen are presented graphically in Figure 3. The release of ammonia from urea was very rapid, reaching a peak at 2 hours after feeding, with little increase from the first to second hours. The decline was almost as rapid as its rise, indicating rapid utilization by the rumen microflora and/or absorption from the rumen into the blood stream. The steer, however, did not show any signs of toxicosis. The level of

TABLE 6

Analysis of variance of the release of ammonia in the presence of urease

Factor	S.S.	Degrees of freedom	Variance	F
Total	246.68	47		
Nutrient with added urease	109.41	3	56.47	85.6**
Nutrient without added urease	8.90	3	2.97	4.5*
Urease	45.00	1	45.00	68.2**
Replicates	0.29	5	0.06	
Remainder	23.08	35	0.66	

* Significant ($P < 0.05$).
** Highly significant ($P < 0.01$).

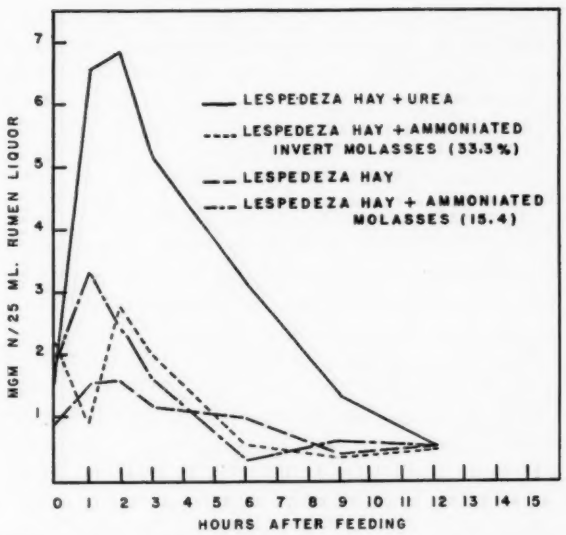

LESPEDEZA HAY + UREA
LESPEDEZA HAY + AMMONIATED INVERT MOLASSES (33.3%)
LESPEDEZA HAY
LESPEDEZA HAY + AMMONIATED MOLASSES (15.4)
MGM N/25 ML. RUMEN LIQUOR
HOURS AFTER FEEDING
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
1 2 3 4 5 6 7

FIG. 3. The release of ammonia nitrogen from urea and ammoniated molasses in the rumen of a fistulated steer.

ammonia reached in the rumen liquor was approximately that reported by Pearson and Smith *(18)*. It is of interest that in the artificial rumen the free ammonia remained at a high level at 6 hours, whereas in the rumen there was a great decline by that time. This is no doubt due to the fact that in the former case there was a closed system, whereas in the rumen the system was moving and microbial activity was greater because of more favorable conditions. Too, it is well known that ammonia is absorbed through the rumen wall in the intact animal, whereas none can escape from an artificial rumen by this means.

The level of ammonia nitrogen in the rumen liquor when ammoniated cane molasses (15.4% protein equivalent) was placed in the rumen was similar to that observed in the artificial rumen. The level of ammonia nitrogen was lower at 6 hours than in the trial in which only hay was fed, indicating apparent utilization by the microflora. No symptoms of toxicity were observed.

The level of ammonia nitrogen in the rumen liquor varied somewhat when the ammoniated invert molasses (33.3% protein equivalent) was placed in the rumen. At 1 hour after feeding the level of ammonia nitrogen was below that observed when lespedeza hay alone was fed, but at 2 hours after feeding the level was slightly above that observed with the other ammoniated molasses. The decline from the second hour followed the same trend observed with urea and the other ammoniated molasses, and at the end of 12 hours there was little difference in the ammonia nitrogen level of the rumen liquor regardless of the ration fed. The decline at the first hour may have been due to a sudden increase in the rumen contents due to a water and/or hay intake or to an error in sam-

pling. It is admitted that these levels of ammonia nitrogen in the rumen liquor are only semi-quantitative in nature, since the situation involves a system constantly moving, heterogeneous in nature, and with opportunities for fluctuation in volume of rumen contents at any time.

SUMMARY

Four series of experiments have been employed to determine the relative amounts of free ammonia nitrogen released from urea, ammoniated cane molasses (15.4% protein equivalent), ammoniated invert molasses (33.3% protein equivalent), and soybean oil meal in the presence of rumen microflora and the enzyme urease.

In the first fermentation series, urea and the two ammoniated molasses were compared by means of the artificial rumen technique. In the second fermentation series, soybean oil meal and the two ammoniated invert molasses were compared by means of an artificial rumen. Urea, soybean oil meal, and the two ammoniated molasses were incubated for 1 hour at 40° C. with and without the presence of the enzyme urease in the media. In a fourth experiment, urea and the two ammoniated molasses were added to the rumen of a fistulated steer subsisting on a diet of Korean lespedeza hay. The level of free ammonia nitrogen in the rumen liquor was determined.

Evidence is presented to indicate that there was some free ammonia in both samples of ammoniated molasses. The amount of free ammonia associated with these materials did not increase significantly with prolonged fermentation in an artificial rumen, nor was there a significant amount released in the presence of the enzyme urease. Considerable amounts of ammonia nitrogen were released from urea in the presence of microflora both in vitro and in vivo and in the presence of the enzyme urease. The release of ammonia nitrogen from soybean oil meal approximated that in a control flask in the presence of rumen microflora in an artificial rumen. The enzyme urease effected release of a significant amount of ammonia nitrogen from soybean oil meal, but this amount was very small compared to the amount released from urea.

REFERENCES

(1) Arias, C., Burroughs, W., Gerlaugh, P., and Bethke, R. M. The Influence of Different Amounts and Sources of Energy upon In Vitro Urea Utilization by Rumen Microorganisms. *J. Animal Sci.*, 10: 683. 1951.

(2) Association of Official Agricultural Chemists. *Official and Tentative Methods of Analysis.* 6th ed. Assoc. Offic. Agr. Chemists, Washington, D. C. 1945.

(3) Burroughs, W., Arias, C., DePaul, P., Gerlaugh, P., and Bethke, R. M. In Vitro Observations upon the Nature of Protein Influences upon Urea Utilization by Rumen Microorganisms. *J. Animal Sci.*, 10: 672. 1951.

(4) Burroughs, W., Latona, A., DePaul, P., Gerlaugh, P., and Bethke, R. M. Mineral Influences upon Urea Utilization and Cellulose Digestion by Rumen Microorganisms Using the Artificial Rumen Technique. *J. Animal Sci.*, 10: 693. 1951.

(5) Dinning, J. S., Briggs, H. M., Gallup, W. D., Orr, H. W., and Butler, R. Effect of Orally Administered Urea on the Ammonia and Urea Concentration in the Blood of Cattle and Sheep, with Observations on Blood Ammonia Levels Associated with Symptoms of Alkalosis. *Am. J. Physiol.*, **153**: 41. 1948.

(6) Dinning, J. S., Briggs, H. M., Gallup, W. D., Ross, O. B., Moe, L. H., and Butler, R. L. Urea in Livestock Feeding. *J. Am. Vet. Med. Assoc.*, **114**: 90. 1949.

(7) Hagemann, O. Contribution to the Knowledge of Protein Metabolic Products (Urea) in the Animal Organism (Translated title). *Landwirtsch. Jahrb.*, **20**: 261. 1891.

(8) Hart, E. B., Bohstedt, G., Deobald, H. J., and Wegner, M. I. The Utilization of Simple Nitrogenous Compounds Such as Urea and Ammonium Bicarbonate by Growing Calves. *J. Dairy Sci.*, **22**: 785. 1939.

(9) Knodt, C. B., Williams, C. B., and Brumbaugh, J. Ammoniated Cane Molasses in the Rations of Dairy Calves. *J. Animal Sci.*, **9**: 661. 1950.

(10) Knodt, C. B., Williams, J. B., and Brumbaugh, J. Ammoniated Cane Molasses and Similar Products in the Rations of Dairy Calves. *J. Dairy Sci.*, **34**: 1042. 1951.

(11) Lenkeit, W., and Becker, M. The Fate of the Urea of "Amidflocken" in the Rumen. (Translated title). *Z. Tierernähr. Futtermittelk.*, **1**: 97. 1938.

(12) McCall, R., and Graham, W. R., Jr. The Value of Several Ammoniated Products as Feed for Beef Cattle. *J. Animal Sci.*, **11**: 770. 1952.

(13) McNaught, M. L., and Smith, J. A. B. Nitrogen Metabolism in the Rumen. *Nutrition Abstr. and Revs.*, **17**: 18. 1947-48.

(14) Magruder, N. D., Knodt, C. B., and Williams, P. S. The Value of Ammoniated Industrial By-Products in the Rations of Dairy Heifers and Cows. *J. Animal Sci.*, **10**: 1055. 1951.

(15) Magruder, N. D., and Knodt, C. B. The Utilization and Value of Ammoniated Industrial By-Products as Sources of Nitrogen for Dairy Cattle. *J. Dairy Sci.*, **36**: 581. 1953.

(16) Mills, R. C., Booth, A. N., Bohstedt, G., and Hart, E. B. The Utilization of Urea by Ruminants as Influenced by the Presence of Starch in the Ration. *J. Dairy Sci.*, **25**: 925. 1942.

(17) Pearson, R. M., and Smith, J. A. B. The Utilization of Urea in the Bovine Rumen. The Conversion of Urea to Ammonia. *Biochem. J.*, **37**: 148. 1943.

(18) Pearson, R. M., and Smith, J. A. B. The Utilization of Urea in the Bovine Rumen. 3. The Synthesis and Breakdown of Protein in Rumen Ingesta. *Biochem. J.*, **37**: 153. 1943.

(19) Perkins, A. T., Merril, J. F., and Rogers, S. N. Urea and Ammoniacal Nitrogen in Miscellaneous Feeding Stuff Products. *J. Assoc. Offic. Agr. Chemists*, **35**: 781. 1952.

(20) Reid, J. T. Urea as a Protein Replacement for Ruminants. *J. Dairy Sci.*, **36**: 955. 1953.

(21) Snedecor, G. W. *Statistical Methods.* 4th ed. The Iowa State College Press, Ames. 1946.

(22) Tillman, A. D., and Swift, R. W. The Utilization of Ammoniated Industrial By-Products and Urea by Sheep. *J. Animal Sci.*, **11**: 777. 1952.

(23) Tillman, A. D., and Swift, R. W. The Utilization of Ammoniated Industrial By-Products and Urea by Sheep. *J. Animal Sci.*, **12**: 201. 1953.

(24) Washburn, L. E., and Brody, S. Growth and Development with Special Reference to Domestic Animals. XLII. Methane, Hydrogen, and Carbon Dioxide Production in the Digestive Tract of Ruminants in Relation to the Respiratory Exchange. Mo. Agr. Expt. Sta., *Research Bull.* 263. 1937.

(25) Wegner, M. I., Booth, A. N., Bohstedt, G., and Hart, E. B. The "In Vitro" Conversion of Inorganic Nitrogen to Protein by Microorganisms from the Cow's Rumen. *J. Dairy Sci.*, **23**: 1123. 1940.

(26) WEGNER, M. I., BOOTH, A. N., BOHSTEDT, G., AND HART, E. B. Preliminary Observations on Chemical Changes of Rumen Ingesta with and without Urea. *J. Dairy Sci.*, **24**: 51. 1941.

(27) WEGNER, M. I., BOOTH, A. N., BOHSTEDT, G., AND HART, E. B. The Utilization of Urea by Ruminants as Influenced by the Level of Protein in the Ration. *J. Dairy Sci.*, **24**: 835. 1941.

(28) WORK, S. H., HAMRE, C. J., HENKE, L. A., AND HARRIS, L. E. A Note on the Effect on the Kidneys and Livers of Feeding Urea to Steers Fattening in Dry Lot and on Pasture. *J. Animal Sci.*, **2**: 166. 1943.

(29) ZUNTZ, N. Observations on the Digestion and Nutritive Value of Cellulose. (Translated title). *Pflügers Arch. Physiol.*, **49**: 411. 1891.

EXCRETION OF DIELDRIN IN THE MILK OF COWS FED DIELDRIN-SPRAYED FORAGE AND TECHNICAL DIELDRIN

RAY E. ELY AND L. A. MOORE
Dairy Husbandry Research Branch

AND

R. H. CARTER, P. E. HUBANKS, AND F. W. POOS
Entomology Research Branch, Agricultural Research Service, USDA
Beltsville, Maryland

Dieldrin[1] is a relatively new insecticide which has been satisfactory for the control of many insects, including species attacking forage crops. Dieldrin is known to be toxic to warm-blooded animals at lower levels of exposure than many of the other chlorinated hydrocarbon insecticides *(5, 6, 7, 8, 10, 11)*. Dieldrin was found in the body fat of farm animals fed 25 p.p.m. in the diet *(4)*, in the liver and kidney of rabbits fed 30 mg. or more of dieldrin per week *(2)*, and in the liver and kidney of rats and rabbits dipped with a dieldrin emulsion *(2)*. Dieldrin has been detected in the milk of cows sprayed at 3-week intervals for tick control *(2)* with 1 gal. per animal of a 0.1% dieldrin spray mixture. The authors are not aware of any reports of dieldrin excretion in milk after feeding sprayed forage or technical dieldrin.

It was the object of this investigation *(a)* to determine if dieldrin is excreted in the milk of cows fed hay made from forage that had been sprayed with dieldrin approximately 1 week before harvesting and *(b)* to study the effect on the concentration of dieldrin in milk of various intakes of dieldrin in soybean oil administered orally.

EXPERIMENTAL PROCEDURE

Two plots of alfalfa in the same field were sprayed with 3.5 oz. and 7.0 oz. of dieldrin per acre on July 7, 1952. For comparison with the experimental applications studied, dieldrin applied at the rate of 1 to 2 oz. per acre has been found effective for the control of grasshoppers. More than a 7-day interval between application and harvesting is usually recommended. The spray material was applied with a weed sprayer that delivered about 6 gal. per acre at a pressure of 40 p.s.i. The sprayer was mounted on a small truck equipped with a specially designed speedometer to aid in obtaining uniform coverage.

Both plots of hay were cut on July 14, 1952, and were field-cured, field-baled, and stored in a hay barn until fed. The hay sprayed with 3.5 oz. of dieldrin per acre was fed to four milking cows from Nov. 15, 1952, to Feb. 27, 1953. The

Received for publication July 1, 1954.

[1] An insecticidal product containing 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-dimenthanonaphthalene.

hay sprayed with 7.0 oz. of dieldrin per acre was fed to the same cows from Feb. 28 to Apr. 15, 1953.

The animals used in this study were normal, healthy milking cows. Two Holstein and two Jersey cows were used in each phase of the study. Each animal was weighed on two successive days at 10-day intervals. All animals were fed sufficient hay to satisfy their appetites and provide a 10 to 15% roughage refusal. Daily records were kept of the amounts of feed fed and refused and the amounts of milk produced. Varying amounts of a milking herd grain mixture were fed, depending upon the level of milk production. Samples of hay were taken from several locations in each bale fed and were composited for analyses for each 10-day feeding period. An aliquot of the milk produced by each animal for 2 days during each 10-day period was used for dieldrin and butterfat analyses.

Dieldrin residues on the hay were calculated from the organic chlorine content (corrected for the organic chlorine content of control hay samples) by the method of Carter and Hubanks *(3)*. Calculations of the dieldrin concentrations in the milk were made from organic chlorine determinations by a modification of the method of Agazzi *et al. (1)* on butter oil prepared from the milk samples by the method of Sager and Sanders *(9)*.

The butter oil was analyzed for organic chlorine compounds as follows: Twenty grams of butter oil was saponified by refluxing for 2 hours with 10 g. of KOH and 150 ml. of ethyl alcohol. The soap solutions were transferred to separatory funnels, using water to make the transfer. The soap solutions were extracted once with 150 ml. of Skellysolve B and twice more with 50-ml. portions of Skellysolve B. The combined Skellysolve B extracts were washed twice with 50-ml. portions of water. The Skellysolve B extracts were then concentrated into small quartz capsules, the excess solvent was removed by an air current, and the residue was burned in a Shell type sulfur combustion apparatus. The concentration of chloride in the absorption bulb was determined by amperometric titration with 0.001 *N* silver nitrate. The apparent dieldrin content of 26 blank samples was calculated to be 0.20 $\pm$ 0.02 p.p.m. This value was used to correct the results on the milk from the cows on the test.

Technical dieldrin (98%) dissolved in soybean oil (100 mg. per milliliter) was administered by capsule twice daily to each of the cows after cessation of the dieldrin-sprayed hay feeding, which was replaced by a control hay containing no insecticide residue. Four cows were fed different amounts of dieldrin for 50 days, and then three of the same animals were fed increased dosages for an additional 40 days.

RESULTS AND DISCUSSION

A summary of the results of feeding the dieldrin-sprayed hay is presented in Table 1. The hay made from forage sprayed with 3.5 oz. of dieldrin per acre had an average 0.4 p.p.m. of dieldrin on the hay when fed. This gave daily intakes of dieldrin ranging from 34.1 to 47.1 mg. per animal. The average con-

TABLE 1

Summary of results of feeding dieldrin-sprayed hay to dairy cows

Animal	Feeding period	Av. daily hay consumed	Dieldrin on hay			Av. daily FCM	Dieldrin in FCM		
	(days)	*(lb.)*	*(p.p.m.)*	*(mg/kg)*	*(mg. daily)*	*(lb.)*	*(p.p.m.)*	*(mg. daily)*	*(% dose)*
N297	54	26.0	0.4	0.11	47.1	15.6	1.0	7.1	15.1
N684	54	18.8	0.4	0.11	34.1	24.9	0.7	7.9	23.2
N699	54	20.0	0.4	0.10	36.3	17.2	0.8	6.3	17.4
N803	54	20.9	0.4	0.09	38.0	28.0	0.9	11.9	31.3
N297	52	25.7	2.9	0.76	338.4	19.6	2.2	19.7	5.8
N684	52	20.0	2.9	0.83	262.3	22.8	1.4	14.9	5.7
N699	52	19.9	2.9	0.72	262.1	12.4	1.6	8.9	3.4
N803	52	23.2	2.9	0.69	305.1	26.2	1.9	23.0	7.5

centrations of dieldrin in the fat-corrected milk (FCM) of these animals for the 54-day feeding period ranged from 0.7 to 1.0 p.p.m. The average daily excretion of dieldrin in the milk ranged from 6.3 to 11.9 mg. From 15.1 to 31.3% of the calculated dieldrin residue on the hay fed was excreted in the milk of these animals during the 54-day feeding period.

The hay made from forage sprayed with 7.0 oz. of dieldrin per acre had an average of 2.9 p.p.m. of calculated dieldrin on the hay when fed (Table 1). The animals receiving this hay had an average intake of 262.1 to 338.4 mg. of dieldrin daily during a 52-day feeding period. The average concentration of dieldrin in the FCM of these animals ranged from 1.4 to 2.2 p.p.m. This represented daily dieldrin excretions in the milk ranging from 8.9 to 23.0 mg. From 3.4 to 7.5% of the calculated dieldrin intake was excreted in the milk of these cows during the 52-day feeding period. Daily observation of the animals indicated that there were no symptoms of hyperexcitability, hyperventilation, muscular tremors, or inappetence during the feeding of either lot of dieldrin-sprayed hay.

A summary of the results of feeding dieldrin in soybean oil is given in Table 2. Intakes of dieldrin ranged from 50 to 1,000 mg. per cow daily. These intakes were equivalent to 0.36 to 8.64 p.p.m. of dieldrin in the ration (hay + grain) or from 0.11 to 2.32 mg. per kilogram of body weight. When these levels of intake

TABLE 2

Summary of results of feeding technical dieldrin in soybean oil to dairy cows

Animal	Feeding period	Dieldrin fed daily			Av. daily FCM	Dieldrin in FCM		
	(days)	*(mg.)*	*(p.p.m.)*	*(mg/kg)*	*(lb.)*	*(p.p.m.)*	*(mg. daily)*	*(% dose)*
N297	50	50	0.36	0.11	18.4	1.7	14.2	28.4
N297	40	100	0.76	0.22	18.1	1.7	14.1	14.1
N699	50	200	1.79	0.54	5.8	1.8	4.7	2.4
N684	50	400	3.34	1.24	23.1	4.2	44.0	11.0
N684	40	600	5.52	1.85	21.5	6.6	64.7	10.8
N803	50	800	5.97	1.81	26.2	9.7	115.0	14.4
N803	40	1000	8.64	2.32	21.7	13.1	128.7	12.9

were fed, the FCM contained from 1.7 to 13.1 p.p.m. of dieldrin, and from 4.7 to 128.7 mg. of dieldrin daily was excreted in the milk. Considerable variation was observed in the percentage of the dieldrin administered that was excreted into the milk; however, when intakes below 100 mg. of dieldrin daily were fed in soybean oil solution (Table 2) or as a residue on sprayed hay (Table 1), higher percentages of the dosage fed were excreted into the milk than when higher intakes were given. The concentration of dieldrin in the milk of cows receiving 50, 100, and 200 mg. of dieldrin daily in soybean oil solution (Table 2) should not be interpreted as being indicative of the precise concentration in the milk when administering these dosages, since these animals had previously received higher intakes of dieldrin on the sprayed forage fed prior to the technical dieldrin-feeding experiment. Subsequent work with the excretion of dieldrin in milk after cessation of dieldrin-feeding (Table 3) indicates that tissue excretion

TABLE 3

The excretion of dieldrin in cow's milk after cessation of dieldrin feeding

		Dieldrin in FCM					
		N297		N684		N803	
		(p.p.m.)	*(mg.)*[a]	*(p.p.m.)*	*(mg.)*[a]	*(p.p.m.)*	*(mg.)*[a]
Av. during feeding periods	(40 days)	1.7	14.1	6.6	64.7	13.1	128.7
After cessation of feeding	7 days	0.7	4.9	3.3	30.1	11.1	102.9
	17 days	0.4	3.0	1.9	16.6	7.7	63.8
	27 days	0.7	5.1	1.3	11.8	5.9	47.0
	37 days	0.4	2.7	1.5	12.5	—	—
	47 days	0.8	5.1	1.1	9.0	2.7	18.4

[a] mg. of dieldrin daily in milk.

of stored dieldrin undoubtedly contributed to the concentrations of dieldrin in milk that are presented in Table 2. Increasing intakes ranging from 400 to 1,000 mg. of dieldrin daily gave progressive increases in the concentration of dieldrin in the milk. No symptoms of toxicity were observed with any of the animals receiving from 50 to 1,000 mg. of dieldrin daily.

The excretion of dieldrin in the milk of three cows after discontinuing dieldrin administration was determined and is reported in Table 3. Two animals (N297, N684) that received 100 to 600 mg. of dieldrin daily for 40 days had approximately a 50% decrease in the concentration of dieldrin in the milk 7 days after cessation of administration. Detectable amounts of dieldrin were still present in the milk of these two cows 47 days after cessation of feeding. The animal receiving 1,000 mg. of dieldrin daily for 40 days (N803) still had approximately 20% as high a concentration in the milk 47 days after cessation of administration as the average concentration during the feeding period. The length of time that detectable amounts of dieldrin were present in the milk of these cows after discontinuing administration was not determined. The relatively high concentration of dieldrin excreted in the milk would indicate rather high storage in the body fat.

SUMMARY

Dieldrin was detected in the milk of four cows when fed hay made from forage that had been sprayed with 3.5 and 7.0 oz. of dieldrin per acre. The average daily dieldrin intakes were 0.10 and 0.75 mg. per kilogram of body weight when the cows were fed the hays sprayed with 3.5 and 7.0 oz. of dieldrin per acre, respectively.

Dieldrin in soybean oil solution was administered by capsule to cows in amounts ranging from 0.11 to 2.32 mg. of dieldrin per kilogram of body weight. The concentration of dieldrin in the fat-corrected milk ranged from 1.7 to 13.1 p.p.m.

Dieldrin excretion in the milk of animals fed from 100 to 1,000 mg. of dieldrin daily continued for more than 47 days after cessation of feeding.

REFERENCES

(1) AGAZZI, E. J., PETERS, E. D., AND BROOKS, F. R. Combustion Techniques for the Determination of Residues of Highly Chlorinated Pesticides by Total Chlorine Analysis. *Anal. Chem.*, **25**: 237. 1953.

(2) BUNDREN, J., HOWELL, D. E., AND HELLER, V. G. Absorption and Toxicity of Dieldrin. *Proc. Soc. Exptl. Biol. Med.*, **79**: 236. 1952.

(3) CARTER, R. H., AND HUBANKS, P. E. Determination of DDT Deposits on Fruits, Vegetables, and Vegetation. *J. Assoc. Offic. Agr. Chemists*, **29**: 112. 1946.

(4) CLABORN, H. V., BOWERS, J. W., WELLS, R. W., RADELEFF, R. D., AND NICKERSON, W. J. Meat Contamination from Pesticides. *Agr. Chemicals*, **8**: 37. 1953.

(5) HAYES, W. J., JR., FERGUSON, F., AND CASS, J. S. Toxicology of Dieldrin and Its Bearing on Field Use of the Compound. *Am. J. Trop. Med.*, **31**: 519. 1951.

(6) LEHMAN, A. J. Chemicals in Foods: A Report to the Association of Food and Drug Officials on Current Developments. Assoc. Food Drug Officials U.S., *Quart. Bull.*, **15**: 122. 1951.

(7) LEHMAN, A. J. Chemicals in Foods: A Report to the Association of Food and Drug Officials on Current Developments. Assoc. Food Drug Officials U.S., *Quart. Bull.*, **16**: 3. 1952.

(8) PRINCI, FRANK. Toxicity of Certain Chlorine-Containing Insecticides for Man. *Med. lavoro.*, **43**: 362. 1952.

(9) SAGER, O. S., AND SANDERS, G. P. A BDI Detergent Test for Butterfat in Milk and Other Dairy Products. *Proc. Milk Industry Found.*, Chicago, Sept. 24-26. 1952.

(10) THORI, A. SH. Toxicity of New Insecticides on Human Beings. *Hadassah*, **32**: 360. 1952.

(11) TILEMANS, EM., AND DORMAL, S. Toxicity of Economic Poisons Toward Man and Warm-Blooded Animals. *Parasitica* (Gembloux), 8: 64. 1952.

IN VITRO STUDIES OF THE EFFECT OF AUREOMYCIN AND TERRAMYCIN ON MIXED SUSPENSIONS OF BOVINE RUMEN BACTERIA[1]

P. JURTSHUK, JR., R. N. DOETSCH, J. J. McNEILL, AND J. C. SHAW
Departments of Bacteriology and Dairy Husbandry, University of Maryland, College Park

There are numerous reports in the literature concerning the use of antibiotics for supplementing diets to produce a favorable growth response in ruminants *(14, 22, 25)*. In the majority of cases this has been observed when aureomycin was fed to calves *(2, 10, 16, 19, 20, 23, 24)*, and there are a few reports which indicate that terramycin also may act as a growth stimulant *(12, 13, 17, 26)*. In addition, observations made by numerous investigators indicate that the stimulating effect of aureomycin in ruminants appears to be greatest during the early part of the growth period *(1, 2, 7, 10, 19, 22, 23)*. This suggests that as the animal matures the effect of aureomycin as a growth stimulant decreases; therefore the age of the calf is very significant with regard to its response.

It is suggested that as the rumen develops, some factor or factors are produced which bind the antibiotic in some way and thus inhibit its activity. If present, it was hoped they would be enzyme-like in nature and therefore susceptible to detection by conventional techniques.

Another study was undertaken to determine what effect aureomycin and terramycin had on the ability of mixed suspensions of rumen bacteria to utilize various carbohydrates. It was previously reported that such mixed suspensions could utilize xylose, arabinose, glucose, maltose, and cellobiose *(4)*. Cultural studies also were conducted to determine the effect of aureomycin and terramycin on actively growing rumen bacteria. Both mixed populations and pure cultures were examined.

EXPERIMENTAL PROCEDURE

Effect of rumen bacteria on the potency of aureomycin and terramycin. Rumen samples were obtained from a 6-year-old Jersey cow fitted with a rumen fistula. Samples were taken approximately 5 hours after the animal was fed alfalfa hay and a grain mixture containing 16% protein. Methodology employed in processing and standardizing the mixed suspension of bovine rumen bacteria for these experiments has been described previously by Doetsch *et al. (4)*. The bacterial suspension was divided into two equal (12-ml.) portions in 125-ml. Erlenmeyer flasks; the cells in one flask were heated to 80° C. for 15 minutes and the cells in the other flask were not heated. One ml. of an aureomycin solution (67.3 mg. aureomycin hydrochloride in 5.0 ml. of *M*/15 phosphate buffer, pH 6.9 ± 0.1) was then added to 6.0 ml. of both the heated and nonheated cell sus-

Received for publication July 8, 1954.

[1] Paper No. A-473, contribution No. 2561 of the Maryland Agricultural Experiment Station.

pensions in 50-ml. Erlenmeyer flasks. Heated and nonheated cells and 1.0 ml. of buffer in place of the antibiotic solution served as controls. The positive control contained 6.0 ml. buffer and 1.0 ml. of aureomycin solution. The flasks were incubated at 39° C. under anaerobic conditions. Anaerobiosis was obtained by flushing the flasks with nitrogen gas and sealing. After 14 hours incubation, the cells were centrifuged out (5,400 × G) and the potency of the antibiotic in the supernatants in each flask was determined. This was done by means of sensitivity tests made with sterile filter paper discs and an aureomycin-sensitive strain of *Micrococcus pyogenes* var. *aureus*. These tests were made on nutrient agar plates (B.B.L.) with various dilutions of the supernatant. The concentration of antibiotic assayed ranged from 960γ per milliliter to 120γ per milliliter (Table 1). A similar procedure was used to determine the effect of rumen fluid

TABLE 1

Zones of inhibition produced by residual aureomycin after incubation with mixed suspensions of bovine rumen bacteria[a]

Aureomycin concentration	Nonheated cells + aureomycin	Heated cells + aureomycin	Buffer + aureomycin
(γ/ml)	*(mm.)*	*(mm.)*	*(mm.)*
960	23	24	33
480	22	23	27
320	21	20	28
240	20	21	26
160	18	17	26
120	16	16	27

[a] Incubation period with antibiotic was 14 hours at 39° C.

per se on the activity of aureomycin. A rumen sample was strained through cheesecloth and 4.0 ml. was incubated with 4.0 ml. of an aureomycin solution (3,000γ per milliliter). Necessary controls were included and the flasks were incubated anaerobically for 3 hours. After incubation the rumen liquor was centrifuged (5,400 × G), and the supernatant was assayed for antibiotic activity.

Another experiment was conducted with terramycin. A slightly modified procedure was used. A solution of terramycin was prepared (1,000γ per milliliter), and 8.0 ml. was added to flasks containing 8.0 ml. of standardized suspension of heated and nonheated rumen cells. Controls were run which contained 8.0 ml. of cell suspension with 8.0 ml. of buffer, and 8.0 ml. of buffer with 8.0 ml. of antibiotic. After 24 hours incubation the cells were centrifuged out (5,400 × G), and sensitivity tests were run as previously described (Table 2). In each of the above experiments sterile filter paper discs were soaked in the supernatants, those containing the antibiotic as well as the controls, and then placed on agar plates seeded with the test organism.

Effect of aureomycin and terramycin on carbohydrate utilization by rumen bacteria. The experimental procedure used for this study was a modification of the one used by Doetsch *et al.* (*4*). The procedure differs in that aureomycin and terramycin were added to flasks containing 3.0 ml. of standardized rumen cell

TABLE 2

Zones of inhibition produced by residual terramycin after incubation with mixed suspensions of bovine rumen bacteria[a]

Reactants	Antibiotic concentration (γ/ml)		
	175	250	500
	(mm.)	(mm.)	(mm.)
Buffer + terramycin	15	18	20
Nonheated cells + terramycin	16	19	22
Heated cells + terramycin	16	19	21

[a] Incubation period with antibiotic was 24 hours at 39° C.

suspension and 4.0 ml. of carbohydrate substrate. The carbohydrates (200μM per flask) used were xylose, arabinose, glucose, maltose, and cellobiose. The concentrations of aureomycin and terramycin used were 100 and 200γ per milliliter per flask, and only 1.0 ml. was added to the flasks receiving the antibiotic. In these macro-fermentation tests, controls consisted of cells plus substrate without antibiotic and cells with antibiotic but without substrate. Buffer was added to each flask to make the final volume 11.0 ml. At various intervals the contents of the flasks were removed and tests were conducted for the presence of carbohydrates with Benedict's reagent for reducing sugars.

Cultural studies. Aureomycin and terramycin were added to Hungate's medium *(9)* prior to inoculation with dilutions of a rumen sample so that the final concentration of antibiotic in the medium was 25γ per milliliter. Preparation of medium (No. 1) and dilution blanks, in addition to the processing procedure, has been described previously *(6)*. After inoculation of both media containing antibiotic and controls without the antibiotic, the tubes were incubated at 39° C. for 48 hours and colony counts were made (Table 3). In addition, penicillin G (crystalline potassium salt), aureomycin (hydrochloride), terramycin (hydrochloride), dihydrostreptomycin sulfate, and chloromycetin (Chloramphenicol) were incorporated into modified Eugon medium *(6)*, omitting agar and sulfide, in concentrations (micrograms per milliliter), respectively, of 1, 1, 2, 20, and 1. Qualitative estimations for growth were made after 24, 48, and 96 hours incubation at 39° C. on 16 pure cultures isolated from the bovine rumen.

RESULTS

Results of experiments on the effect of mixed suspensions of bovine rumen bacteria on aureomycin are presented in Table 1. Upon comparing zones of inhibition, no significant difference is observed between the heated and nonheated bacterial cells. However, a difference in zone diameter is observed between the aureomycin incubated with buffer and the aureomycin incubated with both the heated and nonheated bacterial suspensions. This indicates some nonspecific type of inactivation, most likely due to the protein nature of the cells. Inhibition of the test organism was not observed in the control flasks in the absence of antibiotic.

Similar results were obtained when rumen fluid was incubated with aureomycin. The concentration of aureomycin ranged from 200γ per milliliter to 1,500γ per milliliter, and a nonspecific type of inactivation also was observed. Aureomycin when incubated with phosphate buffer retained more of its activity, after incubation for 3 hours, than did the aureomycin incubated with the heated and nonheated rumen fluid.

The results of the sensitivity tests in which terramycin was used are presented in Table 2. The results indicate that there was no significant or consistent difference between heated and nonheated cells with regard to inactivation of terramycin.

Mixed suspensions of rumen bacteria in the "resting state," when incubated with aureomycin or terramycin (100 or 200γ per milliliter per flask) did not utilize xylose, arabinose, glucose, maltose, and cellobiose as readily as did the controls.

TABLE 3

The effect of aureomycin and terramycin on actively growing rumen bacteria

Hungate's medium containing	Colony count		
	$\times 10^6$	$\times 10^7$	$\times 10^8$
Terramycin (25γ/ml)	0,0,0,0[a]	0,0,0,0	0,0,0,0,0
Aureomycin (25γ/ml)	0,0,0,0,0	0,0,0,0	0,0,0,0,0
No antibiotic (control)	130, 175,[b] 95, 75	40, 24, 35, 120	3, 13, 6, 2, 2, 2, 0

[a] No growth.
[b] Numbers represent actual number of colonies counted.

With regard to the cultural studies, the effects of aureomycin and terramycin on actively growing rumen bacteria are summarized in Table 3. It was observed that when antibiotics were added to Hungate's medium (final concentration of antibiotic 25γ per milliliter) the growth of rumen bacteria was completely inhibited. From this one can conclude that aureomycin and terramycin are definitely detrimental to in vitro growth of rumen bacteria.

Sixteen pure cultures were selected as representative from a much larger collection on the basis of morphology and growth rates. The results of antibiotics on the growth of these cultures are shown in Table 4. Penicillin and terramycin were very active, whereas the three other antibiotics showed slight activity. In no case was stimulation of growth observed with any of the antibiotics.

TABLE 4

Effect of various antibiotics on growth of pure cultures of rumen bacteria

Antibiotic	Concentration	Number of cultures		
		Complete inhibition	Partial inhibition	Unaffected
	(γ/ml)			
Penicillin	1	15	0	1
Aureomycin	1	0	4	12
Terramycin	2	13	2	1
Streptomycin	20	0	3	13
Chloromycetin	1	0	4	12

DISCUSSION

The purpose of the foregoing experiments was to determine whether some explanation could be found for the failure of antibiotic feeding to remain effective after the development of the rumen and its concomitant bacterial flora. From the results obtained in these relatively simple experiments little evidence can be offered that implicates enzymatic inactivation of aureomycin and terramycin either by mixed suspensions of bovine rumen bacteria or by rumen liquor.

Rather high levels of antibiotic were employed in these experiments to facilitate assay and because rapid decrease in potency occurs in the presence of proteinaceous material at 39° C. *(21, 27)*. This fact may partly explain the nonspecific inactivation observed with both rumen bacterial cells and rumen liquor. In addition, aureomycin inactivation may occur in the presence of riboflavin *(8)*, and this also may be a contributory factor since this vitamin is present in rumen liquor *(18)*.

In vitro studies have shown that aureomycin is detrimental to certain rumen bacteria when initially administered to normal calves *(15)*. Constant supplementation of the ration probably involves some adaptation of rumen bacteria to antibiotics as the previously cited study revealed.

If data obtained by these in vitro experiments can be transferred to the intact animal it would seem that aureomycin and terramycin, at the levels employed in this work, interfere with the rapid utilization of carbohydrates most likely to be found in the plant materials of the feed. It is interesting to note that 25γ per milliliter of aureomycin or terramycin added to a rumen sample has little effect on the total count obtained *(11)*. This is interpreted to mean that the action of these antibiotics is bacteriostatic and not bactericidal. On the other hand, 25γ per milliliter of aureomycin or terramycin added directly to the plating medium has a profound effect on the total count, and if it is assumed that a wide variety of authentic rumen bacteria can be cultured on this medium, it is obvious that the effect of these antibiotics on growth is general. The results with pure cultures bear out this contention with regard to terramycin.

The effect of antibiotic feeding on certain "marker" organisms in the rumen and intestinal tract of animals has been touched upon in a few investigations *(3, 24)*. There is still need for more detailed studies in this direction, especially with organisms known to be involved in the physiological reactions of the rumen (*Veillonella, Propionibacterium, Lactobacillus, Bacteriodes*, etc.) and more particularly on the effect of antibiotics on the over-all reactions brought about by the mixed bacterial flora. Such data could be obtained by using methods previously described by this group *(4)*, and studies might well include the effect of antibiotics on aspartate, succinate, and formate dissimilations, as well as polysaccharide synthesis and lactic acid formation from carbohydrates *(5)*. As this group has repeatedly stressed, it seems that in this direction the most fruitful results will be obtained for the efforts expended.

SUMMARY

No significant or consistent difference was observed between heated and nonheated suspension of bovine rumen bacteria in their ability to inactivate aureomycin and terramycin. The presence of a specific heat-labile inhibitor such as an "aureomycinase" could not be demonstrated in either the mixed suspensions of rumen cells or in the rumen fluid itself. A nonspecific type of inactivation was observed in some instances with aureomycin, and this was most probably due to the protein nature of the mixed suspensions of rumen cells.

The presence of both aureomycin and terramycin (100γ per milliliter) definitely decreased the ability of rumen bacteria in the "resting state" to utilize the carbohydrates xylose, arabinose, glucose, maltose, and cellobiose in vitro.

Aureomycin and terramycin when added to a plating medium (final concentration 25γ per milliliter) completely inhibited the growth of bovine rumen bacteria, whereas when this concentration was added to rumen fluid, then plated, it did not.

Suggestions for the direction in which further research on this problem should proceed are presented.

REFERENCES

(1) Bartley, E. E., Fountaine, F. C., and Atkinson, W. F. Effect on Growth of Feeding Aureomycin to Dairy Calves from Birth to Thirteen Months of Age. (Abs.) *J. Dairy Sci.*, **36**: 604. 1953.

(2) Bloom, S., and Knodt, C. B. The Value of Aureomycin and Vitamin B_{12} in Milk Replacement Formulas for Dairy Calves. *J. Dairy Sci.*, **35**: 910. 1952.

(3) Chance, C. M., Smith, C. K., Huffman, C. F., and Duncan, C. W. Antibiotics in Rumen Digestion and Synthesis. III. The Effect of Aureomycin on Rumen Microorganisms, with Special Reference to the Streptococci and Coliform Groups. *J. Dairy Sci.*, **36**: 743. 1953.

(4) Doetsch, R. N., Robinson, R. Q., Brown, R. E., and Shaw, J. C. Catabolic Reactions of Mixed Suspensions of Bovine Rumen Bacteria. *J. Dairy Sci.*, **36**: 825. 1953.

(5) Doetsch, R. N., Robinson, R. Q., McNeill, J. J., Jurtshuk, P., Brown, R. E., and Shaw, J. C. Physiological Studies on Mixed Suspensions of Rumen Bacteria. Md. Agr. Expt. Sta., *Misc. Publ.* 205. 1954.

(6) Doetsch, R. N., Robinson, R. Q., and Shaw, J. C. Techniques Employed in Cultural Investigations of the Bacteriology of the Bovine Rumen. *J. Animal Sci.*, **11**: 536. 1952.

(7) Fincham, R. C., and Voelker, H. H. The Long-Time Effects of Aureomycin Feeding to Dairy Heifers. (Abs.) *J. Dairy Sci.*, **36**: 594. 1953.

(8) Foster, J. W., and Pittillo, R. F. Metabolite Reversal of Antibiotic Inhibition, Especially Reversal of Aureomycin Inhibition by Riboflavin. *J. Bacteriol.*, **66**: 478. 1953.

(9) Hungate, R. E. The Anaerobic Mesophilic Cellulolytic Bacteria. *Bacteriol. Revs.*, **14**: 1. 1950.

(10) Jacobson, N. L., Kaffentzakis, J. G., and Murley, W. R. Response of "Ruminating" Dairy Calves to Aureomycin Feeding. *J. Animal Sci.*, **10**: 1050. 1951.

(11) Jurtshuk, P., Kelley, N., and Doetsch, R. N. Unpublished Results. 1954.

(12) Kesler, E. M. Effect of Terramycin Fed to Holstein Calves on Growth, *In Vitro* Cellulose Digestion and B-Vitamin Synthesis. *J. Animal Sci.*, **13**: 10. 1954.

(13) Kesler, E. M., and Knodt, C. B. Effect of Terramycin on Growth and Rumen Function in Holstein Calves. (Abs.) *J. Animal Sci.*, **11**: 768. 1952.

(14) KNODT, C. B. Antibiotics in the Growth of Ruminant Animals. *Antibiotics and Chemotherapy*, 3: 442. 1953.

(15) LODGE, J. R., MILES, J. T., AND JACOBSON, N. L. The Effect of Aureomycin Feeding to Dairy Cattle on the In Vitro Digestion of Cellulose by Rumen Microorganisms. (Abs.) *J. Dairy Sci.*, 37: 663. 1954.

(16) MACKAY, A. M., RIDDELL, W. H., AND FITZSIMMONS, R. Feed Supplement Containing Aureomycin and Vitamin B_{12} for Dairy Calves. *J. Animal Sci.*, 11: 341. 1952.

(17) MACKAY, A. M., RIDDELL, W. H., AND FITZSIMMONS, R. Terramycin Supplement for Dairy Calves. *J. Animal Sci.*, 11: 19. 1953.

(18) MCELROY, L. W., AND GROSS, H. Quantitative Study of Vitamins in Rumen Contents of Sheep and Cows Fed Vitamin Low Diets. 1. Riboflavin and Vitamin K. *J. Nutrition*, 20: 527. 1940.

(19) MURLEY, W. R., JACOBSON, N. L., AND ALLEN, R. S. Effect of Aureomycin Supplementation on Growth and Feed Utilization of Young Dairy Calves. *J. Dairy Sci.*, 35: 846. 1952.

(20) MURLEY, W. R., JACOBSON, N. L., WING, J. M., AND STODDARD, G. E. The Response of Aureomycin Supplementation of Young Dairy Calves Fed Various "Practical" and Restricted Diets. (Abs.) *J. Dairy Sci.*, 34: 500. 1951.

(21) PAINE, T. F., JR., COLLINS, H. S., AND FINLAND, M. Bacteriologic Studies on Aureomycin. *J. Bacteriol.*, 56: 489. 1948.

(22) REID, J. T., WARNER, R. G., AND LOOSLI, J. K. Antibiotics in the Nutrition of Ruminants. *Agr. Food Chem.*, 2: 186. 1954.

(23) RUSOFF, L. L. A.P.F. Supplements for Calves. (Abs.) *J. Animal Sci.*, 9: 666. 1950.

(24) RUSOFF, L. L., ALFORD, J. H., AND HYDE, C. E. Effect of Type of Protein on the Response of Young Dairy Calves to Aureomycin with Data on the Intestinal Microflora. *J. Dairy Sci.*, 36: 45. 1953.

(25) STOKSTAD, E. L. R. Antibiotics in Animal Nutrition. *Physiol. Revs.*, 34: 25. 1954.

(26) VOELKER, H. H., AND CASON, J. L. Antibiotic Studies with Dairy Calves. (Abs.) *J. Animal Sci.*, 10: 1056. 1951.

(27) WAISBREN, B. A., CARR, C., AND DUNNETTE, J. The Tube Dilution Method of Determining Bacterial Sensitivity to Antibiotics. *Am. J. Clin. Pathol.*, 21: 884. 1951.

TECHNICAL NOTES

Estimation of Vitamin A and Carotenoids in Calf Liver[1]

The Davies method *(3)*, which has been widely used for the determination of vitamin A and carotenoids in liver, entails a multiple ether extraction procedure and thus lacks the simplicity desired in a routine chemical analysis. Modifications of the method have therefore been directed towards decreasing the number of extractions and, in fact, it has been demonstrated that the vitamin A in a properly prepared sample of liver tissue can be considered, from a routine standpoint, to be quantitatively transferred into the ether phase by a single extraction *(1, 5)*.

During the past year, livers from 47 calves, partially depleted of their carotene and vitamin A stores, were analyzed by the Davies method, which has been used in this laboratory for several years, and these results were compared with a single extraction procedure similar to that of Gallup and Hoefer *(4)*.

The whole livers were macerated in a Hobart Food Chopper, sampled and stored at –18° C. for subsequent analysis by the Davies procedure (I) and by a modification of the Gallup and Hoefer method (II).

In both procedures duplicate 7- to 10-g. samples were brought into solution with 20 ml. of 5% aqueous potassium hydroxide by heating on a steam bath for ½ hour with intermittent stirring. The resulting solutions were treated with 5 ml. of aldehyde-free ethyl alcohol and in (I) extracted with two volumes, 50 and 20 ml., respectively, of diethyl ether (peroxide free). The ether extracts were combined, washed free of alkali, dried over sodium sulfate, and made up to volume. Suitable aliquots were read in an Evelyn photoelectric colorimeter for carotenoids and after evaporation in vacuo for vitamin A by the Carr-Price reaction with correction for contribution of carotene to the blue color.

In (II) the saponification was carried out in a 250-ml. iodine flask. After treatment with 5 ml. of alcohol and cooling, about 1 g. of sodium sulfate was added and the mixture extracted with 30 ml. of purified Skellysolve-B by mechanical shaking for 20 minutes. The resulting mixture was transferred to a glass stoppered centrifuge tube and spun for five minutes at 2,000 r.p.m. (Preliminary experiments indicated that efficient extraction of vitamin A was dependent upon the surface area exposed and the duration of shaking.) Suitable aliquots of the Skellysolve-B layer were then analyzed for carotenoids and vitamin A as above.

[1] This study was supported by funds provided by the Chas. M. Cox Company, Boston, Mass., and and the Big-Y-Foundation, Norwich, Conn.

As shown in Figure 1, average values of each liver for vitamin A for both methods were essentially the same: intercept *(a)* not significantly different from 0 and slope *(b)* not different from 1 *(6)*. Average carotenoid values, however, were significantly higher for the Davies method: intercept *(a)* suspected not to be equal to 0 ($P < 0.20$) and slope *(b)* $\pm$ 1 ($P < 0.01$). Variance attributable to duplicate samples in the Davies method was 0.00025 when the vitamin A concentrations were expressed as log of micrograms plus 1. The log expression was necessary since duplicate variance increased with increasing concentration. The variance expressed in the same manner for the modified procedure was 0.00012. For carotenoids duplicate variance, whose magnitude did not appear to have any relation to concentration, over the limited range of values, was 0.0045 for the Davies method and 0.0004 for the modified procedure. The lower duplicate variance values for the modified procedure indicated greater precision, "t" = 2.746 for vitamin A and "t" = 11.640 for carotenoids after correction for correlated data *(2)*.

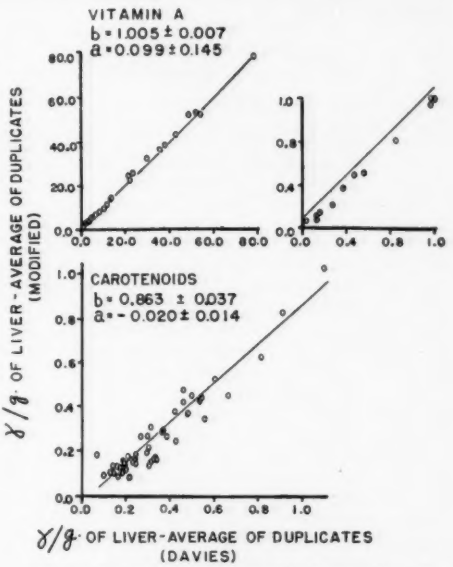

VITAMIN A
b = 1.005 ± 0.007
a = 0.099 ± 0.145
CAROTENOIDS
b = 0.863 ± 0.037
a = - 0.020 ± 0.014
γ/g OF LIVER-AVERAGE OF DUPLICATES (MODIFIED)
γ/g OF LIVER-AVERAGE OF DUPLICATES (DAVIES)

FIG. 1. Regressions of a modified procedure for the estimation of vitamin A and carotenoids on a standard procedure (Davies).

The results of this preliminary study are in general agreement with previous reports *(4, 5)*, i.e. vitamin A was extracted as efficiently with one volume of Skellysolve-B as with two volumes of diethyl ether. In the case of carotenoids, a multiple extraction procedure appears

indicated, since the single extraction resulted in lower recoveries.

R. H. BUNNELL, J. E. ROUSSEAU, JR., AND H. D. EATON
Storrs (Conn.) Agricultural Experiment Station
AND
GEOFFREY BEALL
Department of Statistics
University of Connecticut

REFERENCES

(1) AMES, S. R., RISLEY, H. A., AND HARRIS, P. L. Simplified Procedure for Extraction and Determination of Vitamin A in Liver. *Anal. Chem.*, **26**: 1378. 1954.

(2) COCHRAN, W. G. Queries. *Biometrics*, **7**: 71. 1945.

(3) DAVIES, A. W. The Colorimetric Method of Determination of Vitamin A by Alkali Digestion. *Biochem. J.*, **27**: 1770. 1933.

(4) GALLUP, W. D., AND HOEFER, J. A. Determination of Vitamin A in Liver. *Ind. Eng. Chem., Anal. ed.*, **18**: 288. 1946.

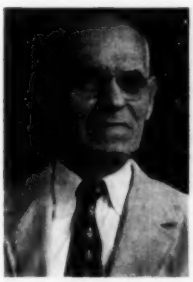
(5) KASER, M., AND STEKOL, J. A. A Critical Study of the Carr-Price Reaction for the Determination of β-Carotene and Vitamin A in Biological Material. *J. Lab. Clin. Med.*, **28**: 904. 1943.

(6) YOUDEN, W. J. *Statistical Methods for Chemists.* John Wiley and Sons, Inc. New York. 1951.

PEOPLE and EVENTS
in the Dairy Science World

Pioneers in the Dairy Industry

This month's pioneer was born on November 11, St. Martin's Day, in 1874, the fifth of a family of ten children in a small village called Yezoo, in southwestern Bohemia. His was a simple and happy childhood. A garden, two cows, and a goat supplied most of the necessary food. A forest nearby supplied a place for play. Two blocks from the home was a building, one half of which was the school, the other half the home of the teacher and his family. Family funds did not permit further education after grade school, so this 12-year-old boy, who was to become one of America's leading dairy bacteriologists, left for a city 15 miles away to begin a 3-year apprenticeship to a baker. His pay was room and board. At the end of that time he received his first educational diploma, signed by the owner of the bakery, the president of the baker's guild, and the mayor of the city. Thus was MARTIN JOHN PRUCHA prepared for life in Bohemia. Soon, however, came the opportunity that many young men of his day dreamed of—a chance to go to America.



M. J. Prucha

At the age of 15, in company with an older sister, he landed in Baltimore, Md., and took a train for Cleveland, Ohio, where he soon obtained a job in a bakery at $9.00 per week. About a year later he was invited to a secret meeting attended by 200 bakers, which had for its purpose the formation of a bakers' union. The newly organized workers struck that night for more wages, and as a result young Martin was temporarily out of a job. He soon was reinstated at an increase in wages, but by that time he had developed a desire for more education. In the fall of 1893 he entered Calvin College in Cleveland. Learning of a place in Massachusetts where a boy could work and go to school at the same time, he transferred the following year to the Mount Hermon School for Boys, founded by D. L. MOODY, the famous evangelist.

The next summer the panic of 1894 was sweeping the country. Work was scarce but young Prucha was equal to the occasion. A minister in a small Cleveland church who wanted to take the summer off was looking for someone to take charge in his absence. Martin applied and was accepted. For 3 months he dispatched all the duties of a small church minister and earned enough money to return to college that fall.

After graduating from Mt. Hermon in 1899, he went on to Wesleyan University, paying his way by serving as chef in a hotel. He received his Ph.B. degree in 1903 and became assistant bacteriologist at the New York State Agricultural Experiment Station. He obtained his M.S. degree from Wesleyan in 1908, his thesis being on the "Bacteriology of Cheddar Cheese." He received a fellowship at Cornell in 1910, where he obtained his Ph.D. degree 3 years later. His thesis topic was the "Physiology of Legume Bacteria." He served on the Cornell faculty as instructor and assistant professor in plant physiology until 1913, when he accepted an appointment as assistant professor of dairy bacteriology at the University of Illinois.

In 1920 Dr. Prucha was made full professor in dairy bacteriology, in which capacity he served until his retirement in 1943, when he became sanitary consultant for the Aeration Processes Corp., Columbus, Ohio.

Besides his studies of the bacteriology of Cheddar cheese, Dr. Prucha did pioneering work in the investigation of bacteria nodule formation on leguminous plants, contamination of milk at the barn during milking, utensils as a source of milk contamination, methods for sterilizing utensils, and the sanitary aspects of paper milk containers. It was in Dr. Prucha's laboratory that the idea of whipping cream by aeration originated while studies were being made of the effect of gas pressure on bacterial growth.

Dr. Prucha had the good fortune to study under several outstanding scientists, including W. H. CONN, often referred to as the father of dairy bacteriology in this country; W. O. ATWATER, who with E. B. ROSA became famous for developing the respiratory colorimeter for humans; V. A. MOORE of the Cornell Veterinary College, another prominent bacteriologist; and B. M. DUGGAR, famous plant physiologist who discovered aureomycin.

Dr. and Mrs. Prucha have three children and six grandchildren. Since 1952 they have lived at 1415 Palmetto St., New Smyrna Beach, Florida.

Regarding the future of the dairy industry, Dr. Prucha says, "Milk is an important part of the diet of people of all ages. Changes and readjustments will have to be made, but the dairy industry is here to stay."

Doctor Prucha, an honorary member of the A.D.S.A., is loved and respected by all who know him, not only for his contributions to the dairy industry but also for his outstanding personality, his fine Christian character, his kindliness, and unselfishness. He has practiced the belief that for a teacher it is not good wisdom to be wise only. He taught his students much more than the subject matter of the course and has well earned a niche in the hall of fame of our dairy pioneers.

Professor S. M. Salisbury Dies

SCHUYLER M. SALISBURY, professor of dairy science at The Ohio State University, died at his home in Columbus, November 26. Professor Salisbury, a graduate of Ohio State with the class of 1913, was born at Collinwood, Ohio, in 1889. He served as instructor in dairying at the North Carolina College of Agriculture and Mechanical Arts 1913-1915; as assistant professor of animal husbandry at Ohio State 1915-18; as agricultural agent, Medina County, Ohio, 1918-20; and as professor of animal husbandry and head of the department, University of Massachusetts, 1920-23. He returned to his alma mater in 1923, where he served on the Dairy Science staff until his death.

Professor Salisbury is survived by his wife and three children, Joseph, a veterinarian of Indianapolis; a daughter, Mrs. Bassel Johnson of Hilliards, Ohio; and Glenn W., professor and head of the Department of Dairy Science at the University of Illinois.

Dairymen to Coordinate on Research Information

A plan designed to speed up dollar returns on the investment in dairy industry research is announced by the Dairywide Coordinating Committee on Nutrition Research.

A five-point program will make nutrition information available to all segments of dairying. The information will be usable in advertising, merchandising, and public relations.

Fourteen dairy organizations will participate. They are: American Butter Institute, American Dairy Assoc., American Dairy Science Assoc., American Dry Milk Institute, American Farm Bureau Federation, Dairy Industries Supply Assoc., Evaporated Milk Assoc., International Assoc. of Ice Cream Mnfrs., Milk Industry Foundation, National Cheese Institute, National Creameries Assoc., National Dairy Council, National Milk Producers Federation, and Purebred Dairy Cattle Assoc. National Dairy Council will be headquarters.

Two subcommittees have been named. They are the Research Survey Subcommittee, which will assemble nutrition research findings, and the Editorial Subcommittee, which will prepare materials based on these findings for use in promoting dairy foods consumption.

The program will function as follows: (1) assemble and evaluate from available sources the consumer and professional attitudes toward dairy foods; (2) review scientific data to provide factual background for public information about dairy foods; (3) suggest additional needed nutrition research which will encompass all phases of human nutrition as affected by dairy foods; (4) present to dairy industry authentic information about dairy foods and formulate recommendations for use in public relations, advertising, and other educational work; and (5) make available to dairy groups an annual summary of dairy industry nutrition research projects in progress, including name of director, location of project, and the objectives.

Personnel Changes in Wisconsin

A. B. EREKSON, formerly director of research for the Lakeshire-Marty Division of the Borden Company, is now with the Company's Pacific Cheese Division, at San Francisco.

J. K. SHERMAN recently joined the staff of the Frozen Semen Dept. of the American Foundation for the Study of Genetics at Madison. Sherman obtained his training at Brown and Western Reserve Universities and recently completed his Ph.D. work in the Univ. of Iowa Dept. of Zoology, his thesis involving studies on the freezing and freeze-drying of human spermatozoa. F. I. ELLIOTT, formerly head of the Animal Industries Dept. at the Univ. of Connecticut, has been in charge of frozen semen research at the Foundation since early in 1954.

E. G. REINHOLZ, former assistant professor of biology at Mission House College, Plymouth, Wis., has recently assumed duties as a bacteriologist with the Dairy Belt Cheese and Butter Company of Spencer, Wis. He is at present heading the research and development program at Spencer and is also engaged in field and quality control work there.

Virginia to Hold Series of Meetings

The Market Milk Conference and Clinic will be held on February 16-17, 1955. The theme of this conference is the HTST as related to modern processing needs.

The Ice Cream Conference and Clinic will be held on March 2-3, 1955. Mix composition as related to body and texture will be discussed from the processing and merchandising viewpoints.

The Cottage Cheese and Buttermilk Conference will be held on March 16-17, 1955. The packaging, merchandising, and quality control aspects of a modern cultured products program will be stressed. The consumer's viewpoint will be of basic importance, inasmuch as the in-

creased per capita consumption of cultured products is a state-wide program.

Milk; strawberry, vanilla, and chocolate ice creams; cottage cheese, and buttermilk will be judged during these conferences.

Dairy Remembrance Fund

Since its initiation a short time ago, a number of organizations and individuals have begun to utilize the facilities of Dairy Remembrance Fund for the honoring of members of the dairy industry. The Fund reports contributions in honor of the following names:

HUGO H. SOMMER	TED HEIDENREICH
PETER TRIMBORN	FRED FLYNN
HENRY N. WOOLMAN	CARL LARSON
CLYDE BEARDSLEE	J. S. SIMS
OSCAR F. STERLING	IRVING KOCH

DONALD R. KELLEM

All contributions are to be used for the published purposes of the Fund and will be allocated at the discretion of its board of directors, representing A.D.S.A.; Dairy Industries Supply Assoc.; Dairy Industries Society, Intern.; Intern. Assoc. of Ice Cream Mnfrs.; Milk Industry Foundation; National Assoc. of Retail Ice Cream Mnfrs.; National Dairy Council; Dairy Industry Committee; and American Dry Milk Institute.

News from Ohio State

A Dairy Fieldmen's Meeting sponsored jointly by the Dept. of Dairy Technology and the Ohio Dairy Products Assoc. was held on Oct. 19. Highlights of the meeting included discussions of the Dairy Economic Outlook, Bulk Milk Handling, Trends in Milk Production, Soil Conservation, and the Importance of the Fieldman in the Dairy Industry.

On Oct. 12, dairy technology students played host to their summer employers on the campus. They toured the campus with special emphasis on the dairy building, visited with the faculty, had lunch together, and attended the Iowa-Ohio State football game in the afternoon.

Thirty undergraduate students attended the Dairy Industries Supply Exposition at Atlantic City the week of October 24. The trip was made by chartered bus.

Notes from Michigan State College

Continued efforts to modernize the dairy curricula at Michigan State College have resulted in a broadening of the graduate program. Formerly the M.S. and Ph.D. degrees were given only in dairy cattle nutrition and dairy manufactures. The addition of new staff members in the areas of dairy cattle breeding and dairy herd management has made it possible to award advanced degrees in these fields. New departmental courses at the graduate level and recent broadening of the subject areas outside of the department supplement these new areas of graduate research.

The 15th annual Michigan State College Dairy Manufactures Conference held on November 3-5 was attended by more than 350 representatives of the industry. A series of products clinics proved popular.

As a special feature of the conference, T. H. BROUGHTON, a Michigan Agricultural College graduate of 1915 and first head of the state's Bureau of Dairy Industry, was presented with the 2nd annual Dairy Manufacturers Award.

The Dept. of Agricultural Engineering in cooperation with the Dept. of Dairy Husbandry will hold its third annual Dairy Engineering Conference March 8 and 9. Current engineering problems of the dairy industry will be discussed by a group of nationally known experts.

The School of Agriculture of M.S.C. will hold a series of ten scholarly symposiums during its centennial year, 1955. The first of these is to be on "The Nutrition of Plants, Animals, and Man" and will be held Feb. 14-16.

The program is designed to interest people who are professionally concerned with the broad field of nutrition. The speakers will review current experiments and assess present knowledge concerning the influence of soil fertility on the nutritive value of animal and human food. Speakers of national and international reputation will participate in the symposiums. The meetings will be held at the Kellogg Center on the campus.

Wiley New Editor of Jersey Journal Magazine

T. E. WILEY has accepted the position of editor of the *Jersey Journal*, official breed publication of the American Jersey Cattle Club in Columbus, Ohio. He previously had been assistant professor at Cornell Univ., where he devoted his time to 4-H Club work with dairy cattle and other classes of livestock. Wiley graduated from Ohio State Univ. in 1948 and later received a Master's degree from the Univ. of Wisconsin.

Frandsen Honored at Massachusetts

Sixty-four alumni, faculty members, and dairy students saw Emeritus Professor J. H. FRANDSEN receive the first Honorary Membership Award at the Univ. of Massachusetts' first Dairy Club Alumni Breakfast, which was held Nov. 6. Professor Frandsen was presented a certificate signifying his election to honorary membership and also a citation which described his many contributions to dairy education. He resides in Amherst and is active as a dairy editor and counselor.

Professor Frandsen was the first editor of

the *Journal of Dairy Science* and served for several years as head of the Department of Dairy Husbandry at Amherst. He is an honorary member of A.D.S.A.

Johnson Joins Idaho Staff

K. R. JOHNSON, who recently completed work for his Ph.D. degree at Purdue Univ., has been made associate professor at the Univ. of Idaho, where he will do teaching and research in the field of dairy cattle breeding.

Promotions at National Dairy Research Laboratories

The appointment of B. H. WEBB as director of research and D. H. BORNOR as director of commercial development has been announced by A. H. JOHNSON, president of National Dairy Research Laboratories, Inc., research division of National Dairy Products Corp.

Webb, who obtained his Ph.D. from Cornell in 1931, joined the staff of the Bur. of Dairy Industry, USDA, in 1926 and became senior dairy manufacturing specialist and later principal dairy technologist. He left the Bureau in 1951 to join the staff of National Dairy Research Labs. as scientific advisor and in 1953 was appointed assistant director of research.

Bornor graduated from the Univ. of Michigan in 1940. He was a member of the pharmacy staff of the Univ. of Michigan Hospital until 1942, when he enlisted in the U. S. Army, where he attained the rank of captain. In 1946 he joined the technical department of Sheffield Farms Co. as supervisor of product development, and in 1949 he joined the staff of National Dairy Research Labs. as project leader in microbiological research. He was appointed assistant to the director of research in 1950 and in 1951 was placed in charge of the new product development section of the Laboratories.

Bandler Wins Milk Industry Foundation Award

D. K. BANDLER (son of N. W. BANDLER, president of the Blue Moon Cheese Co.), a senior in the Dept. of Dairy Industry at Cornell Univ., was awarded the 1954 Milk Industry Foundation Collegiate Leadership Award for the northeast region. The award consisted of a trip to the annual meeting of the Milk Industry Foundation and the Dairy Industry exposition in Atlantic City with all expenses paid, a gift of $100, and a copy of the *Manual for Milk Plant Operations* published by the Foundation.

Since his freshman year Mr. Bandler has been active in the Cornell Dairy Science Assoc. After serving as chairman on over a dozen committees and receiving the Cornell Dairy Science Club Award for being the most active junior in the club, he was elected president of this organization. Since his freshman year he has been an active member on the board of the *Cornell Countryman*, the student publication of the N. Y. State College of Agriculture. During the school year 1952-53 he was advertising manager for the *Countryman;* 1953-54 he was the vice-president of the Boy Scout Service Fraternity, and this year he was a committee member for the Cornell United Religious Workers.

News from N. C. State College

W. E. THOMAS, who has been on temporary appointment, has been made an assistant professor in dairy husbandry. R. B. CASADY has completed a year of study at Johns Hopkins Univ. on physiological climatology and has returned to N. C. State College to resume his duties. J. E. LEGATES was advanced to the rank of professor, and W. R. MURLEY to that of associate professor.

C. W. WALKER, a senior in dairy husbandry at N. C., is the first winner of the Borden Agricultural Scholarship Award of $300. The award is given to the senior who has taken a minimum of two dairy courses and has attained the highest scholastic rating among the eligible students.

A $300 scholarship sponsored by the N. C. Dairy Products Assoc. has been granted to W. Y. COBB, a sophomore in dairy manufacturing.

Louisiana State University Has New Dairy Buildings

A dairy calf barn for nutritional research has been constructed at L.S.U. This building has space for 48 calf pens, storage room for feed, an apartment for students, a biochemistry laboratory, and provisions for radioactive tracer studies. A feature of this barn is an aluminum roof, a gift of Kaiser Aluminum Co., which it is believed will provide the greatest protection from the summer sun.

Funds have been appropriated by the state legislature for a new dairy products manufacturing building which will include a products plant, a research laboratory, and facilities for teaching. All dairy products, including market milk, ice cream, butter, cheese, condensed milk, dried milk, and by-products, will be processed.

Milk production in Louisiana continues to climb, according to a report by B. B. JONES, agricultural manager of the Chamber of Commerce of the New Orleans area. This increase is due to a rise in the number of cows and to increased production per cow. Jones said reports show that in 1952 there were 306,000 milk cows on Louisiana farms; in 1953 there were 324,000; in 1954, 330,000. Better feeding and breeding have been responsible for the in-

crease in production per cow. So far, surplus milk in Louisiana has been a problem only during the spring months.

Personnel Changes Reported from Purdue

K. M. ISAACS, who recently received his M.S. degree, is now employed by the Hales and Hunter Research Laboratories, Chicago. After completing work for the M.S. degree, D. W. MATHER accepted a position with National Dairies, New York City. R. L. WINSLOW has joined the W. K. Moseley Laboratory Staff in Indianapolis, and T. J. URBAN has accepted a position with Creighton Univ., Omaha, Neb. Both of these men recently completed work for the doctorate.

University of Houston Adds Agriculture Department

Through the efforts of the Houston Farm and Ranch Club the Univ. of Houston recently dedicated the first of what it hopes will be a series of demonstration farms. This 160-acre tract is to be used for teaching at both the undergraduate and graduate level and for conducting research and demonstrations on problems related to farming and ranching in that area.

Meetings at University of Maine

A meeting for state institution farm managers was held Oct. 6. The morning session was devoted to inspecting herd and pasture management on the college farm. The afternoon program scheduled discussions on herd management and roughage programs.

The Maine Extension Service and the Maine Breeding Coop. sponsored a technician's course for artificial insemination training which was held at the University October 11 to 13. Members of the Departments of Animal Industry and Animal Pathology contributed to the program.

The Doctors Keeney

It is believed that MARK, DAVID G., and PHILLIP G. KEENEY will be the only three brothers to obtain Ph.D. degrees in dairy manufacturing. Mark and David were awarded the B.S. and Ph.D. degrees by Penn State Univ. and the M.S. by Ohio State. Mark is now associate professor of dairy manufacturing at the Univ. of Maryland. David is chief chemist for Hawley and Hoops, Inc., Newark, N. J. Phillip obtained his B.S. in dairy manufacturing at the Univ. of Nebraska and his M.S. at Ohio State. He is now a member of the Dept. of Dairy Science at Penn State and will be granted the Ph.D. degree by that institution next February.

It is only natural that the Keeneys should manifest an interest in dairying. Their father distinguished himself in this field (1) by being an honor graduate in dairy husbandry at Penn State in 1915—winning the American Jersey Cattle Club Fellowship for superior achievements in cattle judging at the students' contest held in conjunction with the National Dairy Show, (2) through his dairy extension activities in Pennsylvania, Missouri, and New Jersey, (3) by developing one of the country's greatest Holstein herds at the Overbrook Hospital Dairy Farm, Cedar Grove, N. J., beginning in 1923, and (4) by being the author of *Cow Philosophy*, a book which has been popular among breeders of purebred cattle for many years.

Shaw Heads Washington State Group in Pakistan

A. O. SHAW, chairman of the Dept. of Dairy Science, State College of Washington, has been appointed to head a staff of approximately 20, representing the College in various subject matter fields, in an intercollege exchange program between the College and the Univ. of Punjab, Pakistan. This program is under the sponsorship of the U. S. Department of Agriculture.

In addition to serving as chief advisor of the staff group, Shaw is assigned to the Punjab College of Animal Husbandry and Veterinary Science located at Lahore, Pakistan, and will represent the subject matter field of dairy husbandry. He arrived in Pakistan in mid-September and will remain for a period of 2 years. Mrs. Shaw and their two daughters joined him several weeks later. During the absence of Dr. Shaw, H. A. BENDIXEN will serve as acting chairman of the Department.

J. C. KNOTT, director of the Institute of Agricultural Sciences at the State College of Washington, has resigned. As soon as his successor is appointed, Dr. Knott will return to the Dept. of Dairy Science, of which he was a member from 1919 to 1941. He served as director of the Agricultural Extension Service from 1941-46, and since 1946 as director of the Institute of Agricultural Sciences.

LT. COL. JAMES GREENWAY, Reserve Officer, who made national headlines early in October as the Army Colonel who was drawn through the escape hatch of an airliner flying at a high altitude over Indiana and held by his knees dangling at the end of a safety belt, is manager of the Carnation Plant in Seattle. In future air travel it is reported that Col. Greenway will select a seat at a considerable distance from the escape hatch.

What Is Your Philosophy of Good Teaching?

A professor in the College of Agriculture of the Univ. of Illinois recently expressed his viewpoint on teaching as follows:

"My philosophy of teaching stems from the fact that I like and believe in people. I particularly enjoy seeing young people acquire knowledge which will enable them to do better in an occupation, or, equally so if not more important, to live more enjoyable and more useful lives in a society.

"I believe if we are good teachers, we are not only dispensers of knowledge but builders of sound character. I believe that we should encourage young men and women to think; to emphasize the value of exactness; and to point out that honesty and integrity are as important as the acquisition of knowledge."

If you have ideas on this subject and would like to express them to your associates via this column, send them to the editor.

Dairy Export Advisory Committee Recommendations

Recommendations aimed at attacking both the short and long-range problems of the United States dairy industry were embodied in a report of a newly created industry-wide Dairy Export Advisory Committee issued by the U. S. Department of Agriculture. The committee held its first meeting in Washington Sept. 15 and 16. The recommendations comprise the following points:

1. The first responsibility of the United States dairy industry is to produce a sufficient amount of dairy products to meet optimum nutritional standards for our people, and every possible effort should be exerted to bring about the maximum domestic usage of such production.
2. Any excess over and above domestic requirements should be made available for export to areas which do not have sufficient supplies of dairy foods. To foster such export trade, the United States government should use all of its facilities to increase the purchasing power of importing countries by stimulating the creation of markets for the products of such importing countries.
3. We favor the extension of technical assistance by public agencies and private enterprise of the United States in the development of dairying and dairy processing in all friendly nations, in return for which such local production should be supplemented with dairy imports from the United States as a means toward speedily providing these countries with a satisfactory dairy ration.
4. The lack of understanding of the proper place of milk in the diet has been of long standing in milk deficit areas. To overcome these conditions, an educational program is essential and must go hand in hand with any export development project. We urge the President of the United States to use his good offices to obtain the cooperation of other traditional dairy products exporting nations in the development of joint efforts that might lead to the creation of new markets and the absorption of the total world milk production.
5. We do not believe that a system of negotiated prices for the disposition in export markets of surplus United States dairy products would unduly disrupt world prices of dairy commodities. We recommend that the President of the United States explore the possibility of obtaining the cooperation of other dairy products exporting nations in order to establish a fair and equitable level of world prices for dairy products.
6. We do not favor any program which would give away the American surplus of dairy products except as is provided in Titles II and III of Public Law 480 and in the Agricultural Act of 1954, Title II, Sec. 204 (e). We do favor the use of our surplus dairy products as an instrument for the development of a long range dairy export program.
7. We favor the adoption of quality control standards for and the appropriate quality marking of all surplus dairy products exported from the United States.
8. We recommend the discontinuance by the U. S. Department of Agriculture of the practice of publishing the prices at which surplus dairy products, held by the Commodity Credit Corporation, are offered for sale for export from the United States.

The Committee, designed to cover all phases of the dairy industry concerned with export and surplus problems, is composed of 12 members, of which IRVING C. REYNOLDS, Franklin Ice Cream Co., Toledo, Ohio, is chairman.

Surplus Back Numbers of the Journal at Bargain Prices

Shortly after the first of the year back numbers of the Journal of Dairy Science will be moved to Champaign, Ill. Some of the issues prior to Volume 36 are in surplus and will not be moved. These will be available for a short time at the cost of mailing.

If interested in securing any of these numbers, send 25 cents for each issue desired to DR. T. D. HARMAN, Department of Dairy Technology, The Ohio State University, Columbus. If the issues you desire are in surplus they will be mailed to you; if not, your money will be refunded.

It is important to act promptly to take advantage of these bargain prices.

Have You Paid Your Dues?

The plan of sending out notices early this year has been well received by the members and subscribers. If you are one of the few who have not yet responded, please do so promptly. All memberships and subscriptions that have not been renewed by January are automatically removed from the mailing list. Renewals made after that time mean an additional cost to your Association. Send your renewals to Acting Secretary T. D. HARMAN, The Ohio State University, Columbus.

Completed Theses

M.S. Degree:

ERNEST BRYANT—The use of ethyl hydrocaffeate as an antioxidant in stored frozen cream. Louisiana State Univ.

HARVEY HESTER—Aureomycin (chlortetracycline) studies on absorption, distribution, and excretion in the calf. Louisiana State Univ.

E. W. CULVAHOUSE—The growth of dairy calves managed under different conditions. N. C. State College.

R. G. CRAGLE—Studies relating to processing and storage of bull semen at −79° C. N. C. State College.

M. W. CARTER—Nutritional factors in soybean forage influencing reproductive performance of animals. N. C. State College.

R. H. HARTMAN—Effect of various dietary levels of manganese upon the growth and the mineral components in tissues of lambs fed a fortified milk diet containing different levels of magnesium. N. C. State College.

B. R. FARTHING—The genetic covariation between milk production and fat percentage in dairy cattle. N. C. State College.

R. C. BENEDICT—The use of surface-active agents for the preparation of butteroil for analysis. Cornell Univ.

K. M. ISAACS—Induced lactations in dairy cattle with stilbesterol and progesterone. Purdue Univ.

D. W. MATHER—Methods for improving the dispersibility of powdered whole milk. Purdue Univ.

C. A. CRAMER—A study of the cooling efficiency of farm bulk milk tanks. Univ. of Wisconsin.

A. B. KARAS—The use of antioxidants in preventing the solar-activated flavor in homogenized milk. Univ. of Massachusetts.

P. S. SMITH—The keeping quality of creamed cottage cheese in a vacuum package. Univ. of Massachusetts.

Ph.D. Degree:

LESTER HANKIN—Growth stimulation of *Lactobacillus casei* by factors from animal tissues. N. C. State College.

CECIL CONLEY—Study of requirements of iron and copper for dairy calves on a milk diet. N. C. State College.

H. E. KENNEDY—Studies with *Lactobacillus casei* on a bacterial growth stimulant in corn steep. N. C. State College.

D. E. KIZER—The involvement of certain carbon and nitrogen metabolites in the nutrition of *Streptococcus lactis* and *Streptococcus cremoris*. N. C. State College.

R. L. WINSLOW—Studies on the flavor of Cheddar cheese with particular reference to the fat fraction. Purdue Univ.

T. J. URBAN—The effect of manganese on the histology and organ weights. Purdue Univ.

J. A. ELLIOTT—Effects of ultrasonic waves on the bacterial flora of milk. Univ. of Wisconsin.

A. H. MILLER—Bulk assembling of Wisconsin milk, farm to plant. Univ. of Wisconsin.

Positivism or Negativism?

A Guest Editorial

Progress in our country has been spectacular as the result of the pioneer spirit that has prevailed in the minds and hearts of people. This spirit manifests itself by a positive attitude—by being for, rather than against—by taking action in favor of something good rather than by mainly opposing that which is apparently bad. This pioneer spirit stems from an ideology or philosophy which we may call positivism.

I. A. Gould

In recent years, the philosophy which frequently is evident at all levels of our political and industrial life is the direct antithesis of the positive attitude—and which, by contrast, we may call negativism. Whereas positivism is positive good and is based on faith and courage, negativism is against; it is based on uncertainty and fear. Negativism destroys or attempts to destroy something—and may or may not offer something good as a substitute.

In industry public relations, positivism is realism in action. This attitude results in a direct, aggressive, positive program. It makes possible a vigorous promotion of that in which the industry or individual believes and with no public acknowledgment or recognition of that which is in direct opposition. Negativism results when promotion is attempted by destructive criticism of the opposition. Positivism will gain public support and industry cooperation—negativism creates consumer antagonism and industry disharmony.

Negativism has permeated into many industries, and the dairy industry has had its share. The butter substitute controversy is an example. Certainly, the dairy industry abounds with ca-

pable leaders who will insure that the industry at large does not again err in making major decisions which will reflect unfavorably in the minds of the consumer.

Our industry is in an era of great and rapid changes. Practices are common today which were not given favorable consideration even a year or two ago. Research is on the march, and appreciation of the real value of research is probably greater today than ever before. Such appreciation augurs greater industry changes in the immediate future than have been witnessed in a like period in the past. This being the case, an attitude of positivism and not negativism on the part of industry leaders is essential if these changes are faced realistically and if the problems created by these changes are examined in a statesman-like manner.

Dr. Norman Vincent Peale has said, "What you put in your mind will come out. If positive thoughts are put in, positive thinking will come out. If negative thoughts are put in, negative thoughts will come out." If we are to approach in a positive manner the problems which we now have in our industry, and those which are to come, we must put positive thoughts into it.

Where are some areas in which positive thinking is now needed? It is needed in regard to the laws, regulations, and ordinances of states, counties, and municipalities so that free flow of milk will be encouraged and so that the consumer will have dairy products available at the lowest possible price. Positive thinking is necessary in contemplating the use of fats other than milk fat in the manufacture of dairy products. Plato is credited with saying, "When an industry resorts to legislature, it is in the last stages of decay." The industry cannot hide behind legislative acts when new or modified products are involved for which the consumer has demonstrated a real desire. Positive action by industry should not necessarily result in direct promotion of new products; but certainly it would demand a realistic evaluation of the problems involved, the setting forth clearly of standards of differentiation, and the development of a suitable public relations program.

Positive thinking is needed for national sales programs, merchandising, and surplus disposal. The average consumer will admit no allegiance to the dairy industry and cannot be expected to increase his purchases of dairy products out of "loyalty." Neither will he be impressed by the fact that government holdings of such products as wheat and cotton are greater than those of dairy products. Positivism in selling is to create in the consumer's mind a desire for milk and milk products.

Positive thinking is needed in our educational and research work—to make certain the course program, our teaching methods, our extension activities, and our research productivity are all they should be. Positive thinking is necessary in regard to full cooperation between all national dairy groups, which should have as their primary objective "a better dairy industry." Some of the major dairy organizations may well look to their activities, to their personnel, to the effectiveness of their programs. They must make certain that there is no self glorification or smugness—and that they have not lost "the common touch."

Yes—there are many opportunities for the dairy industry to display positivism. However, true statesmanship is required to adopt and practice this philosophy and to realize these opportunities. The answer lies within ourselves.

I. A. GOULD, *Chairman*
Dept. of Dairy Technology
The Ohio State University

LETTERS TO THE EDITOR

Members of the Association:

It is a pleasure to announce that H. F. JUDKINS has been appointed secretary-treasurer of the American Dairy Science Association with the approval of the Executive Board. Mr. Judkins will retire from the National Dairy Products Co. in March and will assume his duties with our association immediately following our next annual meeting. He was president of A.D.S.A. in 1943 and, therefore, already has considerable knowledge of the affairs of the association. Before going into commercial work he was associated with the college and university field of endeavor and has remained an active member of A.D.S.A. through the years. We are fortunate in obtaining the services of one who has had such a distinguished career in the dairy industry.

A special committee of the Executive Board, consisting of Moore, Price, and Gould, explored several possible arrangements for a permanent solution to take care of the business affairs of our association, including the duties of the secretary-treasurer. It was thought that a full-time business arrangement, probably in association with an organization similar to our own, should be developed in the future.

L. A. MOORE
President
American Dairy Science Association

OUR INDUSTRY TODAY

Brief Reviews of Current Topics

Laboratory Training Program of the Robert A. Taft Sanitary Engineering Center in Milk and Food Sanitation

ROBERT P. MYERS

Advanced Sanitation Training Section, U. S. Public Health Service, Cincinnati, Ohio

Technical training courses in environmental sanitation and radiological health, designed primarily for professional personnel from state and local health departments, but including representatives from industry with similar responsibilities, have been conducted by the Public Health Service in Cincinnati for several years. Duration of the courses varies from a few days to 2 weeks with corresponding variation in the breadth of the subject matter covered. Time is allotted to lectures, demonstrations, group discussions, and laboratory practice, with emphasis on the "learn by doing" method in the laboratory *(5)*.

As a result of the surveys of milk laboratories in the War Areas of the U. S. made by DR. L. A. BLACK starting in 1941 *(2)*, it became apparent that special training was needed if uniform laboratory results were to be obtained in the numerous laboratories concerned with control of the sanitary quality of milk. A few states had already established training programs for their laboratory personnel, and others started programs to standardize procedures in milk control laboratories.

After World War II a number of state health department laboratory directors expressed their interest in training courses for their laboratory personnel. Accordingly, the Milk and Food Laboratory of the Public Health Service in Cincinnati conducted a 2-week training course for bacteriologists in charge of milk analyses or food utensil examinations. Representatives from 14 states attended this course. The course was repeated each year until 1952, at which time a 1-week course in bacteriological examination of milk and dairy products and a 1-week course in food sanitation were conducted consecutively. These two courses were preceded by a course in the bacteriological examination of water.

TABLE 1

Attendance at laboratory training courses in milk and other foods held in Cincinnati

	1948	1949	1950	1951	1952	1953	1954	Total
No. of trainees	14	16	10	8	29	30	30	137
No. of states represented	14	14	8	6	14	14	13	33

In Table 1 a brief summary of the number of trainees who have attended the milk and food courses in Cincinnati is presented. In addition to the 33 states represented, the total of 137 trainees includes representatives from within the Public Health Service, from U. S. Military Services, from Puerto Rico, and from three foreign countries.

Food Sanitation Courses

In the food sanitation courses conducted by the Sanitary Engineering Center in Cincinnati the need is emphasized for more laboratory examination of foods as they are served in public eating establishments. Laboratory methods for investigating food-borne disease outbreaks are studied in these courses. From knowledge obtained in investigations of the causes of food poisoning outbreaks, it is possible to establish corrective sanitary measures to prevent the recurrence of such incidents. Periodic laboratory examinations of foods serve as one means of determining compliance with the sanitation program set-up. This preventive sanitary control, in which periodic laboratory examinations constitute one of the important elements of sanitation control, has been successfully applied in the handling of milk. Therefore, it is reasoned that better bacteriological control of the sanitary quality of other foods, the training of food service personnel, and the control of eating and drinking utensil sanitation constitute an improved approach in solving the problem of food poisoning and food-borne disease. The objective of the food sanitation courses is to train laboratory personnel in the techniques which can be most helpful in sanitary food control programs.

Although the problem of food sanitation is more complicated than that of milk sanitation, and more research is badly needed, many of the principles of sanitary control of milk quality that have proven effective might well be applied in improving the sanitary quality of other foods. In the research laboratories of the Sanitary Engineering Center, bacteriological,

chemical and biological methods of testing foods are being studied. As the findings of these and other research laboratories engaged in food sanitation research become available, the results are passed on to the participants in food sanitation training courses at the Center. Laboratory practice in the new chemical, biological, and bacteriological techniques is supplemented with lectures and group discussions.

Milk Laboratory Training Courses

The program of training in the bacteriological examination of milk and dairy products includes laboratory practice in the procedures employed by state, municipal, local, and industrial laboratories engaged in controlling the sanitary quality of milk. Such procedures as sampling, agar plate counts, direct microscopic counts, coliform counts, examination of equipment and containers, and the detection of special groups of bacteria, such as thermoduries and psychrophiles, are covered in the course. Phosphatase tests on pasteurized milk and dairy products are included in this course since the personnel responsible for performing the bacteriological examination are frequently called on to make phosphatase tests.

Selection of procedures outlined in *Standard Methods*, their application in controlling the sanitary quality of milk, the theory underlying these tests, and the interpretation of results receive emphasis. Approximately half of the time is allotted to lectures and informal discussions on these phases and the other half devoted to laboratory practice.

Comparative counts on split samples have proven helpful in demonstrating the need for adhering to standardized procedures, if there is to be agreement between individuals and between laboratories. Deviations from *Standard Methods* occur: *(a)* because workers simply fail to read carefully the prescribed method; *(b)* because individuals interpret directions differently; *(c)* because workers feel they have a procedure that is better than the prescribed method; or *(d)* because a method is difficult to apply and in need of further development. These training courses encourage workers to discuss mutual problems concerned with analytical procedures and interpretation of results. Frequently defective techniques and deviations of which the analyst was previously unaware come to light. Assurance that all analysts are following the same procedures establishes confidence between workers and between laboratories and is vital to the success of the National Interstate Milk Shipment Program.

National Program for the Certification of Interstate Milk Shippers

At the First National Conference on Interstate Milk Shipments in 1950 *(3)* the role of the Public Health Service was outlined as follows: "The state regulatory authorities should carry the work load involved in the interstate milk program, with the assistance of the U. S. Public Health Service. The latter shall be prepared to extend to state regulatory authorities and educational institutions such assistance in the training of field representatives of the state and local governmental units or of industry, field, and plant personnel, and state survey officers as the respective state may require in operating the interstate milk shipment plan. The Public Health Service should also train or assist in training laboratory personnel of state, local, or industrial laboratories as requested by state authorities."

The responsibility for the training of laboratory personnel was assigned to the Sanitary Engineering Center, and the Training Section, within the limitations of its budget, has rendered assistance to the states requesting it, in planning and conducting training courses for milk laboratory technicians. In the fall of 1950, the Missouri Division of Health held a workshop for milk analysts in Columbia, Mo. *(1)*. This was the first of a series of cooperative courses held by state agencies in compliance with the recommendation of the National Conference for Interstate Milk Shipments and was a cooperative undertaking between the University of Missouri, Missouri Division of Health, and the Public Health Service.

Both receiving states and shipping states have conducted similar cooperative short courses during the past 4 years. These states are: Colorado, Florida, Georgia, Minnesota, Mississippi, Missouri, South Dakota, and Wisconsin.

In Table 2 a summary of the Milk Laboratory Workshops that have been conducted in the states listed above is presented. Approximately half of the participants in these courses are from industry or private commercial laboratories.

TABLE 2

Milk laboratory workshops conducted by states in cooperation with the Public Health Service

	1950	1951	1952	1953	First half 1954	Total
No. of state courses	1	4	2	4	3	14
No. of trainees	11	63	46	112	56	288

The courses conducted by different states have varied in duration and course content but, for the most part, have been 5-day courses with something over half the time being devoted to laboratory practice, with demonstrations, lectures, and group discussions completing the schedule. Agar plate count, direct microscopic count, coliform count, phosphatase methods, and tests for sanitization of equipment have been included in all courses, with the major emphasis being devoted to improving the performance of the agar plate method. In some of the courses the dye reduction tests, techniques for detecting and enumerating thermodurie and

psychrophilic bacteria, and methods for the detection of inhibitory substances in milk have been included. Considerable emphasis is placed on comparative tests on split samples as a means of evaluating performance. Items of technique are discussed in light of experience as to the influence of certain deviations from *Standard Methods* on the final results. Representatives of regulatory agencies and milk industry laboratories work together toward the basic objective of milk quality control, which is to provide wholesome, safe milk and dairy products for sale to the consumer.

Uniform State Laboratory Control Program

In order to insure uniform laboratory control each state, according to the Interstate Milk Shipment Program, is responsible for checking the laboratories within its boundaries which are designated to examine milk for interstate shipment. The state agency responsible for approving these laboratories certifies, after appropriate surveys and comparative tests on split samples, that the approved laboratories comply with the provisions of the A.P.H.A. *Standard Methods for the Examination of Milk and Dairy Products*. This constitutes what is usually referred to as "State Certification of Milk Laboratories."

As part of the Program for Certification of Milk Supplies outlined in the National Conference on Interstate Milk Shipments, certification of the laboratories examining milk in connection with the supervision of interstate milk shippers is an important element. Only the interstate shippers having a satisfactory compliance rating and whose supplies are examined by a laboratory approved by the state meet the requirements for listing by the Public Health Service *(4)*. The training program is an effective means of preparing the laboratory personnel for meeting the requirements for certification just as training state rating officials has been an aid in securing uniformity in sanitation compliance ratings.

The objective, then, of these workshops for milk laboratory technicians is to stress compliance with *Standard Methods for the Examination of Milk and Dairy Products*. Performance of the individual workers is measured by the results obtained on split samples which are submitted to the control laboratories twice a year.

REFERENCES

(1) Adams, Irma C. Missouri's Plan for Milk Analysists in the State and Laboratory Certification. *J. Milk Food Technol.*, **14**: 65, 84. 1951.

(2) Black, L. A. Surveys of Milk Laboratories in War Areas in the United States. *Public Health Reports* **58**: No. 44, 45, and 46. 1943.

(3) Editorial. National Conference on Interstate Milk Shipments. *J. Milk Food Technol.* **13**: 194. 1950.

(4) Rowland, J. L. National Conference on Interstate Milk Shipments. June 9-10, 1953. *J. Milk Food Technol.* **16**: 232.

(5) U. S. Department of Health, Education, and Welfare. *Training Programs*, July 1, 1954 to June 30, 1955. (Available from Officer in Charge, Robert A. Taft Sanitary Engineering Center, 4676 Columbia Parkway, Cincinnati 26, Ohio.)

The Bulk Milk Handling and Pipe Line Milking on the Farm

Adoption of System Will Lead to Greater Efficiency

H. E. Calbert

Department Dairy and Food Industries, University of Wisconsin

A number of years ago when the large dairy operations on the west coast turned to bulk milk handling and pipe line milking, it was not surprising. This was a natural development in the methods used there for the mass production and handling of large volumes of milk. However, the acceptance of bulk milk handling and pipe line milking by the average dairyman in other parts of the country, particularly the Midwest, has been most unexpected. Wisconsin may serve as a good example of an area where this change is taking place in the dairy industry. This innovation has been referred to by many milk producers as the greatest development since the milking machine.

In the early part of 1951 there was only one bulk milk pick-up route in the entire state of Wisconsin. This had approximately a dozen patrons and was being operated on a semi-experimental basis. The milk producers were typical dairymen for this area, the smallest having a herd of approximately 15 cows; the largest about 50 cows. None of these producers were using pipe line milking. With the exception of the experimental work being conducted by the University there were very few pipe line milking installations in the state. The few that were in use were primarily for "show" purposes and not in use on the typical dairy farm.

In the brief span of 3 years, the system of bulk milk handling and pipe line milking has received widespread acceptance by Wisconsin dairy farmers. At the present time there are

approximately 30 bulk milk pick-up routes within the state, serving over 1,000 patrons. It must be admitted that this represents a very small percentage of the dairy farms within the state, but it does show a definite trend by the milk producers toward a general adoption of this new method of handling milk. This same trend can be observed in dairying areas in other states. The change to bulk handling and pipe line milking has been even more rapid in sections that are just entering a period of intensive dairy farming.

Why Have Dairymen Adopted Bulk Milk Handling?

Various reasons have been given to account for the rapid conversion from the conventional to the bulk method of milk handling. On most dairy farms mechanization has been the byword in all farming operations with the exception of milking. Although the milking machine has helped to reduce the physical labor needed, this chore still requires the close attention of the persons doing the milking. The milk must be carried away from the cow to the milk house. The milk cans must be lifted, cleaned, and moved by manual labor. Milking utensils must be cleaned and sanitized.

(a) An answer to the labor problem. Farm labor has been at a premium on most Midwest dairy farms during recent years. Research studies, as well as practical experience on many dairy farms, have shown that pipe line milking and bulk milk handling can reduce the amount of labor needed at milking time. This system has enabled some dairymen to increase their herd size, to mechanize the milking operation, and to do a more efficient job of dairying without increasing labor costs. In fact, the labor on many large mechanized dairy farms now is supplied entirely by the dairyman's own family.

(b) A replacement for old equipment. In some areas of the East and Midwest the dairy farmers have been producing milk for the fluid markets for years. On many of these farms the operations have reached the point where they have either outgrown or worn out existing facilities, and the dairymen are faced with the problem of replacement. This would mean the construction of new and larger buildings and the purchase of new equipment. It would require considerable capital investment to obtain new barns, new milk houses, new mechanical coolers, and other new equipment, along with the added expense of more labor. As a result, these dairymen are turning to bulk milk handling and pipe line milking as the answer to their problems. For them it is the least ex-

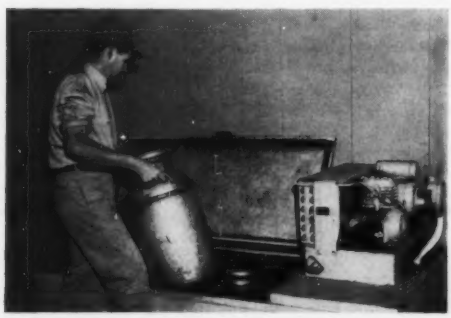


FIG. 1. When the can system of handling milk is used, all milk must be carried from the milking barn to the milk house.

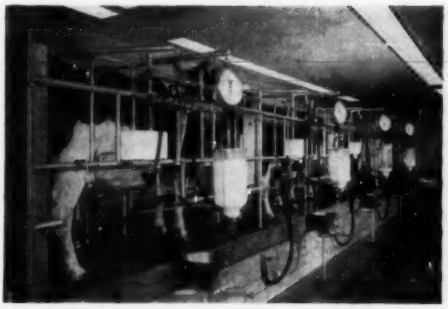


FIG. 2. With pipe line milking, the milk flows from the cow to the bulk milk cooling tank through sanitary lines.

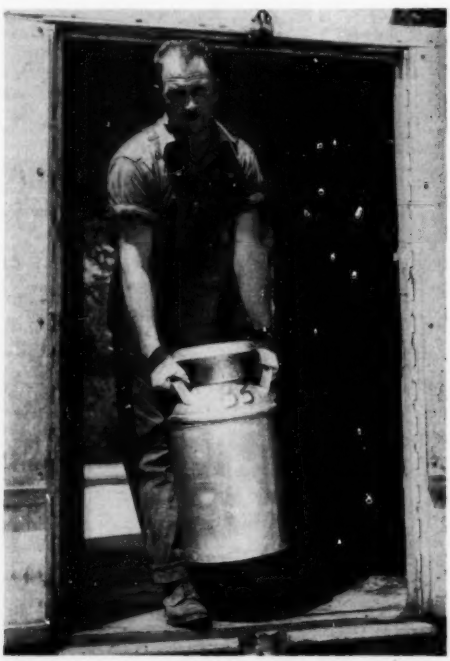


FIG. 3. Each can of milk must be lifted by hand from the milk house onto the milk truck and then unloaded at the dairy plant.

FIG. 4. With bulk handling the milk is pumped from the farm holding tank into the transport tank.

pensive and the most efficient way of improving their milk handling facilities.

(c) A way to a better market. The general unfavorable relationship currently existing between the price of milk and the cost of producing it has served as an incentive for many dairymen to search for better paying markets. Some have been able to sell on premium markets by converting to bulk handling. This has aided them in producing a better-quality milk for markets that are willing to pay a premium for quality products. The increased income for milk produced and handled in this manner has been of substantial help in defraying costs of new equipment and facilities. Also, the resulting reduction in hauling costs has contributed to the dairyman's income.

At this point it might be well to emphasize that bulk milk handling in itself is not responsible for improved quality of milk, as many have been led to believe. It is necessary to put high-quality milk into the bulk tank if one is to expect to remove high-quality milk from the tank. The more efficient cooling of the farm bulk milk tank serves only to protect the high-quality milk that goes into the tank. The system cannot make poor milk better.

Bulk Handling Causes Important Changes in the Industry

Many changes in the dairy industry have come about as the result of bulk milk handling and pipe line milking.

(a) Changes in the milk plant. Smaller dairy plants are converting to complete bulk pick-up. This normally is accompanied by a marked reduction in the number of patrons served by the plant. There is a tendency to keep fewer patrons and those with larger herds. This results in little if any drop in the volume of milk handled by the plant. Often it is easier for smaller plants to change to all bulk pick-up than it is for the larger plants.

When a plant is forced to operate both a conventional receiving room and bulk pick-up routes, the milk handling costs are high. When the plant changes to 100% bulk pick-up, it is able to save on receiving room costs, transportation costs, and in other ways. By passing some of these savings on to the milk producer in the form of lower hauling costs, premiums for high-quality milk and the like, it has enabled some of the smaller plants to maintain a favorable competitive position in relation to the larger dairy operations in the area.

Originally the earlier bulk milk pick-up routes were in areas that were serving mainly fluid milk markets. Now bulk routes are being operated by cheese factories, drying plants, and creameries. Bulk-handled milk is going into manufactured dairy products as well as into fluid use.

(b) Changes on the dairy farm. The adoption of bulk milk handling and pipe line milking has caused important changes on the dairy farm. It has been the experience of many dairymen who have changed to this new system that they soon thereafter increased their production. They usually find that they can keep more cows without additional help.

There is a tendency toward a more uniform production throughout the year. By utilizing the equipment at or near its capacity over the entire year, the unit cost of milk production and handling can be reduced, thus resulting in a more efficient operation.

Going hand in hand with bulk milk handling and pipe line milking is the change to the use of loose housing for the dairy cattle and the use of milking parlors. Bulk handling works well with these types of operations. The result again is a more efficient job of milk production and handling.

Problems of the New System

Any new development is normally enshrouded with problems. Bulk milk handling and pipe line milking have been no exceptions.

(a) Minimum size of dairy herd. The first question that arises is how large must the dairy herd be to make this system economical? The answer is difficult to obtain. In a study made on the west coast it was found that for the 10-cow herd it costs $103 more per year to handle milk by the conventional can system than by the bulk system. As the herd size increased, the differences in costs in favor of the bulk system also increased.

The size of herd that represents the break-even point between bulk handling and can handling depends on more than just the number of cows in the herd. Each installation must be decided on the basis of the present cost of operation, the potential income in using the bulk handling, the future production and market possibilities, and many personal factors that only the dairyman himself can decide. It is known that many dairymen have changed to the bulk system more as a matter of convenience than of economy.

(b) The small producer. When a bulk milk pick-up route is established in a given area, there are always some milk producers who cannot change to this system because of the small size of their operations or their limited finances. The problem then arises as to what to do with their milk. As yet this problem has not become too serious, as there are usually outlets in the area for the can-handled milk. However, as bulk handling becomes more common, the problem of the small producer will become more acute. Will his days be numbered in the dairy business? Can several small producers combine their milking operations to form a larger dairy unit? Can the small producer economically convert to some modified type of bulk handling? Only time can answer these questions.

(c) Equipment costs. The conversion to bulk handling and pipe line milking requires a considerable investment on the part of the dairyman. Although various methods have been used for financing the change, the basic problem of trying to reduce the actual cost of the equipment still remains. The smallest of the farm bulk milk holding tanks costs approximately $1,500. Pipe line milker installations vary in price from $30 to approximately $100 per cow. Few farmers can convert to the new system for much less than $2,500 to $3,000. If means could be found to reduce the cost of the equipment, the adoption of bulk milk handling would increase more rapidly.

(d) Cleaning farm milk pipe lines. The cleaning and sanitizing of farm bulk milk holding tanks presents no great problem. Practices now used on other types of dairy equipment can be readily applied here. The same cannot be said of pipe line milkers. To obtain full advantages of pipe line milking, the lines should be cleaned in place. As yet, no method for cleaning and sanitizing milk lines in place has been devised that will work in all installations at all times. Part of the fault lies in the installation of the milk lines. Many lines have been installed without proper consideration being given to ease of cleaning. The engineering and installation of farm milk pipe lines should be standardized in order to simplify cleaning procedures.

Then too, the dairy farmer has created part of his own problems. Many farmers started out by cleaning their pipe lines in place, with excellent results, but as time passed they have tried to initiate "short cuts" or have become lax in following the proper procedures for in-place cleaning, with the result of a reduction in the quality of the milk. One solution to this problem would be the use of a device for automatic cleaning of farm pipe lines. Devices of this type are now in use in automatic dishwashers and automatic clothes washers. Such an installation would enable the dairyman to press a button and walk away feeling assured that the cleaning and sanitizing of his milk pipe line would be done in the proper sequence of the cleaning cycle and with solutions at the correct temperature.

Future of the Bulk Milk System

The question arises frequently as to what is the future of the bulk milk system. Is it here to stay, or is it just a passing fancy? Certainly, it is here to stay. It is becoming an integral part of dairying in the United States. Acceptance of this system will increase. Its growth may not be as spectacular as it has been in the last few years, but there should be a steady upward trend. No doubt better equipment and, it is hoped, less expensive equipment will be developed for the bulk system of handling milk and pipe line milking. Like any other type of dairy equipment, the bulk handling system must go through a period of evolution. Its development to date has been satisfactory, and improvement should continue in the future.

The responsibility for the evaluation of milk quality is gradually shifting from the regulatory authorities to the dairy plant receiving the milk. This places an obligation on the driver of the bulk milk pick-up truck that is not experienced by the average milk hauler and presents new opportunities to properly qualified persons. Recognition of this change in responsibility is evident in the 1953 issue of the United States Public Health Service Recommended Milk Ordinance and Code.

Bulk milk handling will enable smaller dairy plants to offer effective competition in their areas. It will give them a new lease on life and a means of achieving more efficient operation. The mere fact that both milk for fluid uses and that for manufactured uses are now being handled by the bulk system gives rise to the thought that the bulk system may be one important factor that will contribute to the day when there is only one grade of milk—the top grade.

CALL FOR PAPERS FOR THE 1955 ANNUAL MEETING OF THE AMERICAN DAIRY SCIENCE ASSOCIATION

The 50th annual meeting of the American Dairy Science Association will be held June 21, 22, and 23, 1955, at the Michigan State Agricultural College, East Lansing.

Members who wish to present papers must furnish titles and abstracts not later than March 1. Two copies of each abstract must be mailed to the chairman, another to the vice-chairman, and a fourth to the secretary of the section before which the paper will be given. Abstracts must not contain over 200 words. Terminology should be understandable by the general reader. It is essential that titles and abstracts be received by March 1 so that the complete program may appear in the Journal of Dairy Science for May and so that the abstracts may be printed for distribution at the annual meeting. If time limitations make it necessary, some papers may have to be read by title only. No member should plan to present more than one paper. Reactions of those attending previous meetings indicate that papers presented by members in industry and by senior members of the Association are especially well received.

Members prefer to receive mimeographed copies of essential material which must be presented visually; such material includes tables of data, graphs, and brief summaries. Material for projection on screens should be used only if the preferred method is impossible.

Names and addresses of officers of sections to whom titles and abstracts will be sent are:

Extension Section

Chairman: E. T. Itschner, Department of Dairy Husbandry, University of Missouri, Columbia

Vice-Chairman: George Werner, Department of Dairy Husbandry, University of Wisconsin, Madison

Secretary: James Burke, 1469 Slaterville Road, Ithaca, N. Y.

Manufacturing Section

Chairman: G. H. Hartman, 102 Revere Drive, White House Milk Co., Manitowoc, Wis.

Vice-Chairman: W. M. Roberts, Department of Animal Industry, North Carolina State College, Raleigh

Secretary: H. L. Templeton, 6125 Florence Blvd., Omaha, Neb.

Production Section

Chairman: R. E. Erb, Department of Dairy Science, State College of Washington, Pullman

Vice-Chairman: N. P. Ralston, Dairy Department, Michigan State College, East Lansing

Secretary: G. W. Trimberger, Department of Animal Husbandry, Cornell University, Ithaca, N. Y.

AUTHOR INDEX OF ORIGINAL ARTICLES[a]

ADAMS, R. S., effects of tocopherol on calves receiving filled milks, 655*; oxidative metabolism in mammary particulate, 671*

AFFSPRUNG, H. E., activity of calcium salts in casein sols, 634*; ionic availability in milk, 643*; trace elements in whole milk, 643*; inorganic equilibria in milk, 1409

ALBRIGHT, J. L., effects of calcium borogluconate on cows with parturient paresis, 661*

ALDERMAN, G., characteristics of sodium meta-bisulfite silage, 659*

ALEXANDER, M. H., labor requirements for milk pipeline operation, 583

ALLEN, N. N., effects of restricted roughage and high concentrate diets, 660*

ALLEN, R. S., response of calves to antibiotics and arsenicals, 654*; effect of ground corn on grass silage, 658*; *in vivo* studies with surface-active agents, 737; blood B-vitamin levels in calves fed aureomycin, 1190; effects of varied rates of hay feeding, 1233

ALMQUIST, J. O., effect of milk proteins upon spermatozoan livability, 220; effect of cysteine on livability of spermatozoa, 650*; techniques for freezing spermatozoa, 652*; effect of dehydrated grass on bull fertility, 1123; effect of lactenin and lactoperoxidase upon spermatozoan livability, 1205; fertility of spermatozoa in heated milk, 1303; heated milk and egg yolk–citrate as semen diluters, 1308

ANDERSON, E. O., cell counts of herd milk, 919; evaluation of student dairy products judging, 1021

ANDERSON, Z. E., promoting use of milk products, 467

ANDREWS, R. H., destruction rate of psychrophilic bacteria in skimmilk, 317

ARBUCKLE, W. S., identification of fat globules in ice cream, 642*

ARCHIBALD, J. G., a simple test of quality in hay, 552; composition of grass silage, 1283

ARMSTRONG, T. V., detection of substitute fats in dairy products, 481

ARNOLD, P. T., ensiling forages with citrus pulp, 658*

ARRINGTON, L. R., bacteriological studies of milk from menadione fed cows, 636*; effect of menadione on susceptibility of milk to oxidized flavor, 640*; availability of phosphorus, 661*; inhibition of oxidized flavor of milk, 819

ASHWORTH, U. S., dispersibility of spray-dried milk, 648*; wettability method for powdered milk, 863

ATKESON, F. W., effects of aureomycin upon growth of calves, 259; pure vs. crude aureomycin products for calves, 982; predicting lifetime production of Indian cattle, 1273

AURAND, L. W., stimulation of lactic acid bacteria, 634*; nutrition of lactic acid bacteria, 635*

AUTREY, K. M., portable pens vs. conventional housing for calves, 562; nutritional value of *Lespedeza sericea*, 666*

BABB, E. M., JR., bulk milk dispenser operations, 642*

BABCOCK, C. J., filtration method for dry buttermilk solids, 631; evaluation of student dairy product judging, 1021; freezing characteristics of homogenized and unhomogenized milk, 1416

BABEL, F. J., slime formation on cottage cheese, 176; changes in milk flora caused by bactericides, 635*

BAIRD, D. M., gain by heifers on winter grazing crops, 1435

BAKER, J. M., activity of calcium salts in casein sols, 634*; ionic availability in milk, 643*; trace elements in whole milk, 643*; inorganic equilibria in milk, 1409

BALDWIN, C. S., inheritance of black hair patterns in cattle, 1368

BARTLEY, E. E., effects of aureomycin upon growth of calves, 259; pure vs. crude aureomycin products for calves, 982

BAUM, E. L., management practices and net returns in Washington, 14

BAYLEY, N., laboratory tests for evaluating semen fertility, 1050

BEALL, G., effects of vacuum level and milking duration, 276; effect of form of alfalfa on carotenoid and vitamin A content of milk, 311; lactation response to dehydrated and pelleted alfalfa, 523; effect of vitamin A depletion on blood constituents, 857; carotene vs. vitamin A for feeding calves, 889; relationship between plasma and liver vitamin A in calves, 1376; estimation of vitamin A and carotenoids in calf liver, 1474

BEARDEN, H. J., fertilization and embryonic mortality rates for bulls in AI, 649*

BECKER, R. B., ensiling forages with citrus pulp, 658*

BELL, R. W., use of sucrose in frozen condensed skimmilk, 648*

BENDIXEN, H. A., dispersibility of spray-dried milk, 648*; training dairy technologists, 1397

BENNETT, E., a simple test of quality in hay, 552

BENNETT, F. W., sanitizing teat cup inflations, 640*; action of aerosols on bacteriophage, 840; action of viricides on bacteriophage, 847

BENSON, E. T., dairy research to the rescue, 912

BHALERAO, V. R., detection of foreign fats in dairy products, 156

BIRD, E. W., buffer capacities of skimmilk, buttermilk, and butter serum, 641*

BISHOV, S. J., sedimentation of milk proteins, 634*

BLACK, W. G., fertilization rates and embryonic death rates, 691

BLAKE, J. T., *In vivo* studies with surface-active agents, 737

BLOCK, R. J., electrolytic deionization of protein-free whey, 932

BLOSSER, T. H., levels of blood constituents in parturient cows, 185; effects of calcium borogluconate on cows with parturient paresis, 661*

BODA, J. M., dietary calcium and phosphorus and milk fever, 360

BOHMAN, V. R., utilization of molasses and urea in rations, 284

BONEWITZ, E. R., 4-H club production records in Kansas, 676*

BOYD, E. N., longevity of spermatozoa in pasteurized milk, 650*

BRADT, C. G., brucellosis is being wiped out, 1141

BRANDT, P. M., guideposts for the dairy industry, 352

BRANTON, C., blood studies of breeding bulls, I, 30; metabolic responses of spermatozoa to antibacterial agents, 228; factors affecting fertility of bulls, 653*

* Abstract of paper presented at the annual meeting.

[a] Prepared by W. O. NELSON, Univ. of Illinois.

Bratton, R. W., fertilization and embryonic mortality rates for bulls in AI, 649*; fertility results with frozen spermatozoa, 651*; relationship between fertility and number of spermatozoa inseminated, 1353; fertility of bulls ejaculated at different intervals, 1441; fertility of bulls ejaculated at 8-day intervals, 1444

Bratzler, J. W., characteristics of sodium metabisulfite silage, 659*; trials with sodium metabisulfite silage, 659*

Brence, J. L., utilization of colostrum for feeding calves, 655*

Brody, S., effect of wind on cows, 674*

Brost, B., relation of gestation period to birth weight of calves, 162; calving age and intervals between calvings, 672*

Brown, R. E., etiology and treatment of ketosis, 661*; methane formation by rumen bacteria, 662*

Brubaker, R. E., effect of ensiling on onion and ragweed flavors, 58

Bryant, M. P., cellulolytic rod-shaped rumen bacteria, 1176

Bucek, W., chromatographic study of milks, 538

Buckner, P. J., laboratory tests for evaluating semen fertility, 1050; fertility of spermatozoa stored at 5° and −79° C., 1429

Bullock, D. H., effect of *G. candidum* on development of Cheddar cheese flavor, 637*

Bunnell, R. H., estimation of vitamin A and carotenoids in calf liver, 1474

Burger, M., homogenization and deaeration of milk by ultrasonic waves, 645*

Burke, J. D., New York production and feeding analysis for DHIA herds, 675*

Calbert, H. E., influence of bulk handling raw milk on rennet coagulation time, 637*; use of lyophilized lactic starter, 637*; preserving lactic starters by lyophilization, 639*; bulk milk handling and pipeline milking, 1486

Campbell, L. E., use of acidifying salts in silage, 659*

Carneiro, G. G., reproduction and growth of cattle in Brazil, 1145

Carter, R. H., feeding aldrin to cows, 294; excretion of dieldrin in milk, 1461

Casady, R. B., errors in assaying fecal androgens, 72

Casida, L. E., factors affecting age at puberty in heifers, 252; fertilization rates and embryonic death rates, 691

Chance, C. M., source and effect of nutrients on production in DHIA herds, 675*

Chandlee, P., buffer capacities of skimmilk, buttermilk, and butter serum, 641*

Chicoye, E., causes of hay flavor in vitamin A fortified low-fat milk, 1346

Christian, L. T., coliforms from pasteurized milk, 636*

Chung, A. C., etiology and treatment of ketosis, 661*

Cleaver, T., dairy farm building design and construction, 1392

Cleveland, G. W., undecorticated safflower meal for milk production, 671*

Cohen, S. H., assay of cows' urine for pregnanediol, 355

Cole, H. H., dietary calcium and phosphorus and milk fever, 360

Comar, C. L., effects of feeding iodinated casein, 659*

Combs, W. B., use of demonstrations in dairy science teaching, 345; use of *P. roqueforti* mutants in cheese, 711

Committee, ADSA, standardized procedures for Babcock test for milk, 761; public relations objectives of ADSA, 769

Conrad, E. O., fertility of spermatozoa stored at 5° and −79° C., 1429

Conrad, H. R., rumen synthesis of thiamine and riboflavin, 512; volatile fatty acids in rumen of calves, 664*; effects of feeding aureomycin, 724

Copland, D. V., effects of thyroprotein feeding, 877

Cornely, K. W., protein stability in frozen concentrated milk, 830

Cosimini, J., determining total solids with the lactometer, 869

Coulter, S. T., peroxide test for lipid oxidation, 202; manufacture of low heat nonfat milk solids, 476; use of Venturi atomizer in spray drier, 647*; oxygen uptake by milk, 648*

Cowan, R. L., characteristics of sodium metabisulfite silage, 659*; trials with sodium metabisulfite silage, 659*

Cragle, R. G., factors affecting recovery of frozen spermatozoa, 652*

Craine, E. M., apyrase activity of the mammary gland, 498; phosphokinase activity of the mammary gland, 505; activity of phosphate esters in mammary gland extracts, 1027

Cremers, L. F., identification of fat globules in ice cream, 642*

Crowley, J. W., sulfur dioxide preservation of legume silage, 52

Crown, R. M., parenteral administration of aureomycin to calves, 488

Cruthers, J. C., fertility results with frozen spermatozoa, 651*

Culvahouse, E. W., effect of management and housing on calves, 656*

Cunningham, H. M., effect of fat-free diets on calves, 453

Cupps, P. T., histology of the pituitary, testis, and adrenal, 1074

Dack, G. M., effect of emulsifier on *C. botulinum*, 640*

Dahlberg, A. C., free amino acids in cheese, 167

Dalton, H. L., factors affecting excretion of chromic oxide, 672*

D'Arensbourg, G. F., factors affecting fertility of bulls, 653*

Davis, G. K., ensiling forages with citrus pulp, 658*; availability of phosphorus, 661*

Davis, H. P., relation of gestation period to birth weight of calves, 162; type score related to production, 666*; calving age and intervals between calvings, 672*

Davis, L. R., portable pens vs. conventional housing for calves, 562

Davis, P. A., slime formation on cottage cheese, 176

Davis, R. F., sulfur to nitrogen ratios in feeds, 813

Davis, R. N., stability of ascorbic acid in milk, 641*

Davis, R. R., continuous vs. rotational grazing, 665*

Dembiczak, C. M., lactation response to dehydrated and pelleted alfalfa, 523; effect of vitamin A depletion on blood constituents, 857; relationship between plasma and liver vitamin A in calves, 1376

DENTON, T. W., antibiotics for calves, 653*
DEUTSCH, H. F., permeability of the gut of herbivores, 653*
DIAMOND, S., Richardson pregnancy test applied to cattle, 662*
DODGE, W. A., dairyman's "Bridge of Life," 674*
DOETSCH, R. N., nutritional requirements of rumen bacteria, 81; aspartate dissimilation by rumen bacteria, 531; polysaccharide synthesis and lactic acid production by rumen bacteria, 662*; effect of rumen bacteria on antibiotics, 663*; cellulolytic rod-shaped rumen bacteria, 1176; effects of antibiotics on rumen bacteria, 1466
DOLGE, K. L., relationship between plasma and liver vitamin A in calves, 1376
DONKER, J. D., effect of oxytocin-induced udder evacuation, 299; Richardson pregnancy test applied to cattle, 662*; factors affecting excretion of chromic oxide, 672*; effects of hourly milking with aid of oxytocin, 1261
DOWNS, P. A., evaluation of student dairy products judging, 1021
DRACY, A. E., effect of relaxin upon milk ejection, I, 1173
DUFOUR, L., sulfur dioxide preservation of legume silage, 52
DUNBAR, R. S., JR., genetic analysis of components of type and production in Ayrshires, 667*; approximate indexes for butterfat production, 668*
DUNCAN, C. W., nutrient value of corn silage, 957
DUNGAN, G. H., yield and protein content of corn silage, 976; evaluation of corn silage, 1088
DUNN, H. O., fertility of spermatozoa stored at 5° and −79° C., 1429
DUPRE, W. M., response of cows to postpartum management, 673*
DURRELL, W. B., effect of terramycin on growth of calves, 654*
DZIUK, P. J., technique of electroejaculation, 1035

EATON, H. D., fat globule surface area and carotenoid and vitamin A content of milk, 147; effects of vacuum level and milking duration, 276; effect of form of alfalfa on carotenoid and vitamin A content of milk, 311; lactation response to dehydrated and pelleted alfalfa, 523; colostrum as milk substitute in a feeding system, 655*; effect of vitamin A depletion on blood constituents, 857; carotene vs. vitamin A for feeding calves, 889; relationship between plasma and liver vitamin A in calves, 1376; estimation of vitamin A and carotenoids in calf liver, 1474
EDMONDSON, J. E., lactobacilli found in milk, 634*
EDMONDSON, L. F., sedimentation rates of milk proteins, 633*
EHLERS, M. H., breeding efficiency related to number of gestations, 673*
ELDRIDGE, F. E., predicting lifetime production of Indian cattle, 1273
EL-HAGARAWY, I. S., factors affecting organic acid production of propionibacteria, 638*
ELLIOTT, F. I., effects of vacuum level and milking duration, 276
ELLMORE, M. F., effect of soybeans on plasma carotene and vitamin A of calves, 1269
ELLSWORTH, P. R., proceedings 49th annual meeting ADSA, 990
ELY, F., influence of mixed ejaculates upon fertility, 649*; activation of spermatozoa by sodium bicarbonate, 651*
ELY, R. E., feeding aldrin to cows, 294; holocellulose from feeds and feces, 664*; excretion of dieldrin in milk, 1461
ENGEL, R. W., studies with grazing dairy animals, 665*
ERB, R. E., condition of cows at time of artificial breeding, 672*; breeding efficiency related to number of gestations, 673*; factors affecting nonreturn decline following artificial service, 938; factors affecting distribution and nonreturn decline of repeat service intervals, 949
ERICKSON, W. E., factors affecting revival rate of frozen spermatozoa, 651*
ETCHELLS, J. L., sweet potato vine silage, 1325
EZZARD, W. T., sanitizing teat cup inflations, 640*

FAGEN, H. J., estimation of lactose in dairy products, 10
FARTHING, B. R., genetic covariation between milk yield and fat percentage, 668*
FECHHEIMER, N. S., inheritance of black hair patterns in cattle, 1368
FINNEGAN, E. J., bulk milk dispenser operations, 642*
FISHER, H. L., grazing behavior of lactating cows, 665*
FLAKE, J. C., the public looks at milk sanitation, 1399
FLERCHINGER, F. H., condition of cows at time of artificial breeding, 672*; factors affecting nonreturn decline following artificial service, 938; factors affecting distribution and nonreturn decline of repeat service intervals, 949
FLIPSE, R. J., effect of milk proteins upon spermatozoan livability, 220; glucose C^{14} uptake by spermatozoa, 425; effect of cysteine on livability of spermatozoa, 650*; effect of dehydrated grass on bull fertility, 1123; effect of lactenin and lactoperoxidase upon spermatozoan livability, 1205; fertility of spermatozoa in heated milk, 1303
FOHRMAN, M. H., measurements of Jersey and Sindhi-Jersey cows, 1420
FOOTE, R. H., fertility results with frozen spermatozoa, 651*; services and per cent nonreturns in AI, 673*; relationship between fertility and number of spermatozoa inseminated, 1353; fertility of bulls ejaculated at different intervals, 1441; fertility of bulls ejaculated at 8-day intervals, 1444
FOSGATE, O. T., effect of oxytocin on milk and fat production, 195; prenatal mortality in the bovine, 1071
FOSSLAND, R. G., histological development in the post-natal bovine testis, 669*
FOUNTAINE, F. C., effects of aureomycin upon growth of calves, 259; pure vs. crude aureomycin products for calves, 982
FOURT, D. L., undecorticated safflower meal for milk production, 671*
FOUTS, E. L., bacteriological studies of milk from menadione fed cows, 636*
FRAM, H., protein stability in frozen concentrated milk, 830
FRANKEL, E. N., estimation of free fatty acids in rancid milk and cream, 646*
FREDERICK, E. C., factors affecting revival rates of frozen spermatozoa, 651*
FREEMAN, A. E., genetic analysis of components of type and production in Ayrshires, 667*
FREEMAN, N. K., unsaturated fatty acids of milk fat. III. geometrical isomerism, 399
FROKER, R. K., problem of dairy surpluses, 113

FRYE, J. B., JR., cottonseed meal, urea, and ammoniated molasses in rations, 657*; response of bulls to subtropical climate, 667*
FRYER, H. C., effects of aureomycin upon growth of calves, 259; milk viscosity as affected by homogenization, 642*; pure vs. crude aureomycin products for calves, 982
FUSSELL, J. M., parenteral administration of aureomycin to calves, 488

GALL, L. S., fiber digestion in miniature artificial rumen, 328; parenteral administration of aureomycin to calves, 488
GANDER, J. E., effects of tocopherol on calves receiving filled milks, 655*; ATP-ase activity in mammary particulate, 670*; oxidative metabolism in mammary particulate, 671*
GARDNER, K. E., "filled milk" for veal production, 431; feeding antioxidants to calves, 654*
GAUNYA, W. S., colostrum as milk substitute in a feeding system, 655*
GEBERT, M., the self-help program, 628
GEHRKE, C. W., activity of calcium salts in casein sols, 634*; ionic availability in milk, 643*; trace elements in whole milk, 643*; spectrographic determination of metals in milk products, 1401; inorganic equilibria in milk, 1409
GESSERT, R. A., etiology and treatment of ketosis, 661*
GILMAN, H. L., effects of antibacterial agents on *V. fetus*. I. added to semen extenders, 407; II. in naturally infected semen, 416
GILMORE, L. O., effect of feeding potassium iodine, 660*; inheritance of black hair patterns in cattle, 1368
GLENN, W. E., changes in flora of cultured buttermilk during ripening, 1128
GORDON, C. H., use of acidifying salts in silage, 659*; feeding value of alfalfa hay, 1116
GOULD, I. A., factors affecting organic acid production of propionibacteria, 638*; lipases of raw skimmilk, 644*; material adsorbed on milk fat globule, 644* effect of heat on antibiotics in milk, 647*; free fatty acid content of milk, 717
GRAF, G. C., studies with grazing dairy animals, 665*; grazing behavior of lactating cows, 665*
GRAHAM, E. F., factors affecting revival rate of frozen spermatozoa, 651*; technique of electroejaculation, 1035
GRANDAGE, A., errors in assaying fecal androgens, 72
GREEN, B., response of bulls to subtropical climate, 667*
GREENBANK, G. R., xanthine oxidase in dairy products, 644*; effect of xanthine oxidase on dairy products, 644*
GREGOIRE, A. T., effects of vacuum level and milking duration, 276
GRIFFITH, W. S., factors affecting fertility of bulls, 653*
GROSCHE, C. A., HTST pasteurization of ice cream mix, 37
GULLICKSON, T. W., effects of tocopherol on calves receiving filled milks, 655*
GUNTHARDT, H., dispersibility of spray-dried milk, 648*; wettability method for powdered milk, 863
GUTHRIE, E. S., factors affecting oxidized flavors in milk, 641*; flavor of fresh concentrated milk, 647*
GUY, E. J., characterization of milk amylases, 644*

HAFS, H. D., fertility of spermatozoa stored at 5° and −79° C., 1429
HALL, A. C., services and per cent nonreturns in AI, 673*
HALL, H. H., sweet potato vine silage, 1325
HAMDY, M. K., free amino compounds in starters, 645*
HANKIN, L., HTST pasteurization of ice cream mix, 37; stimulation of lactic acid bacteria, 634*
HANSEL, W., fertilization and embryonic mortality rates for bulls in AI, 649*; isolation of causative agent of hyperkeratosis from wheat concentrate, 662*
HANSEN, H. H., effect of form of alfalfa on carotenoid and vitamin A content of milk, 311
HANSEN, R. G., apyrase activity of the mammary gland, 498; phosphokinase activity of the mammary gland, 505; feeding antioxidants to calves, 654*; activity of phosphate esters in mammary gland extracts, 1027
HAQ, M. O., aureomycin and vitamin B_{12} supplementations for cows, 677
HARDISON, W. A., herbage selection by grazing cattle, 89; grazing behavior of lactating cows, 665*; studies with grazing dairy animals, 665*
HARGROVE, R. E., survival and growth of Swiss cheese bacteria, 638*
HARLAND, H. A., peroxide test for lipid oxidation, 202; manufacture of low heat nonfat milk solids, 476
HARMON, L. G., factors affecting cottage cheese quality, 637*
HARPER, W. J., detection of substitute fats in dairy products, 481; factors affecting organic acid production of propionibacteria, 638*; free amino and fatty acids in Swiss cheese, 639*; low-fat soft-ripened cheese, 639*; lipases of raw skimmilk, 644*; free amino compounds in starters, 645*; free fatty acid content of milk, 717
HARSHBARGER, K. E., yield and protein content of corn silage, 976; evaluation of corn silage, 1088
HARTLEY, C. B., microflora of Blue cheese slime, 436
HATZIOLOS, B. C., fat metabolism in mammary glands of cows, 924
HAWK, H. W., factors affecting age at puberty in heifers, 252
HAWKINS, G. E., JR., portable pens vs. conventional housing for calves, 562; blood serum magnesium of calves, 656*; nutritional value of *Lespedeza sericea*, 666*
HAYS, R. L., effect of epinephrine on lactation in the rat, 670*
HEINEMANN, B., determining total solids with the lactometer, 869
HELMBOLDT, C. F., effect of vitamin A depletion on blood constituents, 857; carotene vs. vitamin A for feeding calves, 889
HENDERSON, B. W., JR., microflora of vulvo-vaginal mucosa, 671*
HENDERSON, C. R., influence of roughage on biochemical properties of milk, 1; genetic variation in rate of maturity and level of production, 668*; approximate indexes for butterfat production, 668*; relationship between fertility and number of spermatozoa inseminated, 1353; fertility of bulls ejaculated at 8-day intervals, 1444
HERALD, C. T., lactones and off-flavor of milk fat, 646*

HERLICH, H., portable pens vs. conventional housing for calves, 562
HERMAN, H. A., maintenance of osmotic conditions during semen storage, 684
HERRINGTON, B. L., lipase: a review, 775
HERZER, F. H., evaluation of student dairy products judging, 1021
HESS, C. V., influence of dairymen's knowledge on success and actions, 1255
HESS, E. A., influence of mixed ejaculates upon fertility, 649*; activation of spermatozoa by sodium bicarbonate, 651*
HESTER, H. H., effect of aureomycin on blood constituents of calves, 654*
HIBBS, J. W., rumen synthesis of thiamine and riboflavin, 512; effect of feeding potassium iodine, 660*; volatile fatty acids in rumen of calves, 664*; effects of feeding aureomycin, 724
HICKMAN, C. G., genetic variation in rate of maturity and level of production, 668*
HILL, D. L., assay of cows' urine for pregnanediol, 355
HINTZ, P. C., free amino and fatty acids in Swiss cheese, 639*
HIRT, F. S., determining ease of dispersion of milk powder, 648*
HOLDAWAY, C. W., pastures for milk production, 666*
HOPPER, J. H., "filled milk" for veal production, 431
HOSTERMAN, W. H., feeding value of alfalfa hay, 1116
HUBANKS, P. E., feeding aldrin to cows, 294; excretion of dieldrin in milk, 1461
HUFFMAN, C. F., nutrient value of corn silage, 957
HUFNAGEL, C. F., effect of xanthine oxidase on dairy products, 644*
HUGE, T. L., fly and rodent control in processing plants, 348
HUHTANEN, C. N., fiber digestion in miniature artificial rumen, 328
HUPFER, J. A., factors affecting phosphatase test, 698
HURST, V., frozen skimmilk as semen diluter, 650*
HUSSONG, R. V., estimation of lactose in dairy products, 10
HYDE, C. E., parenteral administration of aureomycin to calves, 488

INCHIOSA, M. A., influence of dams and sires upon breeding efficiency of daughters, 667*
IRVIN, H. M., use of acidifying salts in silage, 659*
IRVINE, O. R., effect of *G. candidum* on development of Cheddar cheese flavor, 637*

JACK, E. L., unsaturated fatty acids of milk fat, I. methyl ester fractionation and monoethenoid constituents, 380; II. conjugated and nonconjugated constituents, 390; geometrical isomerism, 399; determining total solids with the lactometer, 869
JACKSON, H. W., identity of malty substance from milk cultures of *S. lactis* var. *maltigenes*, 1316
JACOBSON, N. L., long-time effects of antibiotic feeding, 657*; effect of aureomycin on *in vitro* cellulose digestion, 663*; *in vivo* studies with surface-active agents, 737
JACOBSON, W. C., plant pigments as indicator of digestibility, 672*; hemoglobin levels in blood of calves, 805
JAMIE, W., recruitment and training college graduates in the dairy industry, 116
JENNESS, R., peroxide test for lipid oxidation, 202; characterization of milk amylases, 644*; oxygen uptake by milk, 648*; manufacture of low heat nonfat milk solids, 476
JENSEN, R. G., lactobacilli found in milk, 634*
JEZESKI, J. J., microflora of Blue cheese slime, 436; use of *P. roqueforti* mutants in cheese, 711; bleaching milk and cream with benzoyl peroxide, 1241
JOHNSON, B. C., "filled milk" for veal production, 431
JOHNSON, G. F., new developments in dairy visuals, 675*
JOHNSON, J. D., cow activities in loose-housing, 269
JOHNSON, P. E., effect of cysteine on livability of spermatozoa, 650*
JOHNSON, R. E., effect of form of alfalfa on carotenoid and vitamin A content of milk, 311; lactation response to dehydrated and pelleted alfalfa, 523; colostrum as milk substitute in a feeding system, 655*
JOHNSTON J. E., blood studies of breeding bulls, I, 30; response of bulls to subtropical climate, 667*; physiological response of bulls to extreme climatic conditions, 667*
JONES, I. D., sweet potato vine silage, 1325
JORDAN, R. M., effect of relaxin upon milk ejection, I, 1173
JUNGHERR, E. L., effect of vitamin A depletion on blood constituents, 857; carotene vs. vitamin A for feeding calves, 889
JURTSHUK, P., JR., effect of rumen bacteria on antibiotics, 663*; effects of antibiotics on rumen bacteria, 1466

KANE, E. A., plant pigments as indicator of digestibility, 672*
KAUFMANN, O. W., destruction rate of psychrophilic bacteria in skimmilk, 317
KEENER, H. A., factors affecting vitamin D in forages, 1337
KEENEY, M., detection of milk fat adulteration, 646*; compounds producing Kreis and thiobarbituric acid reactions, 647*
KEENEY, P. G., lactones and off-flavor of milk fat, 646*
KELLGREN, H. C., factors affecting fertility of bulls, 653*; response of bulls to subtropical climate, 667*
KELLY, P. L., type score related to production, 666*
KENDALL, K. A., changes in blood proteins associated with parturition, 662*
KENDRICK, J. F., changes of DHIA forms, 676*
KENNEY, H. E., nutrition of lactic acid bacteria, 635*
KEYES, E. A., utilization of colostrum for feeding calves, 655*; effect of alfalfas on milk production, 657*; effects of thyroprotein feeding, 877
KIDDER, H. E., fertilization rates and embryonic death rates, 691
KILPATRICK, B. L., cottonseed meal, urea, and ammoniated molasses in rations, 657*
KING, W. A., response of cows to postpartum management, 673*
KINNEY, W. C., JR., survival of sperm at sub-zero storage, 650*
KIRKHAM, W. R., stimulation of the rat mammary gland, 669*

KIZER, D. E., stimulation of lactic acid bacteria, 634*; acetate–citrate metabolism of *S. lactis* and *S. cremoris*, 635*
KLEIN, M. G., trends in food packaging, 1251
KLOSER, G. M., detecting substitute fats in ice cream, 647*
KNODT, C. B., milk replacement formulas for calves, 373, 655*; dicyanodiamide as nitrogen extender in rations, 657*
KOSHI, J. H., effects of oxytocin-induced udder evacuation, 299; effect of intervals between milking on production, 673*; effects of hourly milking with aid of oxytocin, 1261
KOSIKOWSKY, F. V., free amino acids in cheese, 167; heat processing curd into Mozzarrelle cheese, 639*; decarboxylation of amino acids in cheese, 645*
KRIENKE, W. A., bacteriological studies of milk from menadione fed cows, 636*; effect of menadione on susceptibility of milk to oxidized flavor, 640*; inhibition of oxidized flavor of milk, 819; assay of cheese for antibiotics, 1184
KRISTOFFERSEN, T., metabolism of amino acids by *L. casei*, 635*
KRONENWETT, F. R., thermal death time of *B. abortus* in milk, 636*, 1291
KRUKOVSKY, V. N., influence of dietary roughages on susceptibility of milk to oxidized flavors, 641*; influence of roughage on biochemical properties of milk, 1
KUMAR, S., beta hydroxybutyric acid metabolism of the mammary gland, 669*; tracer studies of milk secretion, 670*
KUMMEROW, F. A., detection of foreign fats in dairy products, 156
KURAMOTO, S., bleaching milk and cream with benzoyl peroxide, 1241
KUZMESKI, J. W., composition of grass silage, 1283

LABEN, R. C., histology of the pituitary, testis, and adrenal, 1074
LAKSHMANAN, S., beta-hydroxybutyric acid metabolism of the mammary gland, 669*; tracer studies of milk secretion, 670*
LAMASTER, J. P., role of dairy industry in utilizing our inexhaustible resources, 472; frozen skimmilk as semen diluter, 650*
LANDAGORA, F. T., effect of aureomycin on blood constituents of calves, 654*
LANG, A. L., yield and protein content of corn silage, 976
LARSON, B. L., heat denaturation of milk serum proteins, 633*; changes in blood proteins associated with parturition, 662*
LARSON, G. L., fertility of spermatozoa stored at 5° and –79° C., 1429
LASSITER, C. A., antibiotics for calves, 653*; effects of grass pasture(s) grazing, 665*
LAWRITSON, M. N., type score related to production, 666*
LAWTON, W. C., factors affecting growth of psychrophilic bacteria, 636*; effects of storage temperatures on psychrophilic organisms, 1164
LAZAR, J. T., JR., measuring efficiency of labor utilization in milk plants, 642*
LEAR, S. A., thermal death time of *B. abortus* in milk, 636*, 1291
LEE, D. H. K., measurements of Jersey and Sindhi-Jersey cows, 1420
LEFFLER, R. W., the Wisconsin cheese exchange, 909
LEGATES, J. E., genetic covariation between milk yield and fat percentage, 668*; a selection index for fat production, 744
LEWANDOWSKI, T., milkstone formation, 640*
LEWIS, R. C., cow activities in loose-housing, 269
LEWIS, W. M., sweet potato vine silage, 1325
LINKOUS, W. N., studies with grazing dairy animals, 665*
LLEWELLYN, R. W., analysis of plant cleaning operations, 1198
LODGE, J. R., effect of aureomycin on *in vitro* cellulose digestion, 663*
LOEWENSTEIN, M., material adsorbed on milk fat globule, 644*
LOGAN, V. S., effect of alfalfa maturity on milk production, 247
LONG, J. F., effect of feeding potassium iodine, 660*
LOOSLI, J. K., influence of roughage on biochemical properties of milk, 1; utilization of molasses and urea in rations, 284; effect of fat-free diets on calves, 453; factor required by a rumen bacterium, 663*; sulfur to nitrogen ratios in feeds, 813
LUCAS, H. L., errors in assaying fecal androgens, 72
LUCAS, H. L., JR., HTST pasteurization of ice cream mix, 37
LUDWICK, T., influence of mixed ejaculates upon fertility, 649*; activation of spermatozoa by sodium bicarbonate, 651*
LUNDSTEDT, E., manufacture of quality cream cheese, 243
LUSH, J. L., a selection index for fat production, 744; reproduction and growth of cattle in Brazil, 1145
LUSH, R. H., alfalfa-orchard grass grazing, 664*

MAGRUDER, N. D., dicyanodiamide as nitrogen extender in rations, 657*
MAHAFFEY, J. C., factors affecting excretion of chromic oxide, 672*
MAKI, L. R., effects of restricted roughage and high concentrate diets, 660*
MALANEY, G. W., changes induced in casein by *S. agalactiae*, 633*
MARDEN, W. G. R., electroejaculation of the bull, 556
MARLEY, G. P., analysis of plant cleaning operations, 1198
MARSHALL, S. P., pangola-white clover pastures, 666*
MARTIN, C. M., herbage selection by grazing cattle, 89
MARTIN, T. G., effects of varied rates of hay feeding, 1233
MARTIN, W. H., Reichert-Meissl numbers of Kansas butterfat, 646*
MAXCY, R. B., fat separation in evaporated milk, I. homogenization, separation, and viscosity tests, 60; II. age thinning of concentrated, sterilized milk, 306; III. gravity separation and heat stability, 1061
MAYER, D. T., maintenance of osmotic conditions during semen storage, 684
MAYNARD, L. A., fortification of whole milk and skimmilk, 624
MEAD, S. W., histology of the pituitary, testis, and adrenal, 1074
MEITES, J., antagonism between mammary growth and lactation, 669*

MELIN, C. G., use of acidifying salts in silage, 659*
MERRILL, W. G., blood constituents at parturition and after adrenocorticotrophin administration, 546; leucocytes of cows with parturient paresis, 967
METZGER, H. J., thermal death time of *B. abortus* in milk, 636*, 1291
MEY, C. W., management practices and net returns in Washington, 14
MEYERS, R. P., laboratory training program in milk and food sanitation, 1484
MIDDLETON, M. D., effect of xanthine oxidase on dairy products, 644*
MILES, J. T., long-time effects of antibiotic feeding, 657*; effect of aureomycin on *in vitro* cellulose digestion, 663*
MILLER, L. F., influence of dairymen's knowledge on success and actions, 1255
MILLER, W. J., factors affecting survival of frozen spermatozoa, 45; factors affecting excretion of chromic oxide, 672*
MITCHELL, J. H., JR., sedimentation of milk proteins, 634*
MIXNER, J. P., factors affecting survival of frozen spermatozoa, 651*; glycerol interference in staining spermatozoa, 652*, 1094
MOCHRIE, R. D., effects of vacuum level and milking duration, 276; colostrum as milk substitute in a feeding system, 655*; replacing hay with corn silage for cows, 657*
MONROE, R. A., effects of feeding iodinated casein, 659*
MONTAVON, P., making the farm feed the herd, 905
MOORE, L. A., feeding aldrin to cows, 294; effect of form of alfalfa on carotenoid and vitamin A content of milk, 311; lactation response to dehydrated and pelleted alfalfa, 523; holocellulose from feeds and feces, 664*; hemoglobin levels in blood of calves, 805; effects of thyroprotein feeding, 877; carotene vs. vitamin A for feeding calves, 889; feeding value of alfalfa hay, 1116; cartilage width in normal and rachitic calves, 1220; relationship between plasma and liver vitamin A in calves, 1376; excretion of dieldrin in milk, 1461
MORGAN, M. E., identity of malty substance from milk cultures of *S. lactis* var. *maltigenes*, 1316
MORRIS, H. A., use of *P. roqueforti* mutants in cheese, 711
MORRISON, R. A., breeding efficiency related to number of gestations, 673*
MORRISON, S. H., digestibility of honeysuckle, 173; Richardson pregnancy test applied to cattle, 662*
MOSS, S., alkaline phosphatase and glycogen in the uterus, 671*
MUCHA, T. J., use of sucrose in frozen condensed skimmilk, 648*; baking quality of frozen condensed and dried skimmilk, 649*
MUELLER, W. S., antioxidative properties of cacao, 754
MURLEY, W. R., effect of management and housing on calves, 656*; replacing hay with corn silage for cows, 657*
MURRAY, D. L., television in extension programs, 674*
MURTHY, G. K., effect of resin mixtures on skimmilk salts, 571
MUSGRAVE, S. D., phosphorus requirements of bulls, 653*
MYERS, R. M., factors affecting recovery of frozen spermatozoa, 652*
MYKLEBY, R. W., fortification of skimmilk with nonfat dry milk solids for cottage cheese, 637*
MACLEOD, P., cell counts of herd milk, 919
MACVICAR, R., phosphorus requirements of bulls, 653*
MCCALL, J. T., ensiling forages with citrus pulp, 658*
MCCULLOUGH, M. E., gain by heifers on winter crops, 1435
MCDOWELL, R. E., measurements of Jersey and Sindhi-Jersey cows, 1420
MCENTEE, K., isolation of causative agent of hyperkeratosis from wheat concentrate, 662*
MCGILLIARD, L. D., long-time effects of antibiotic feeding, 657*
MCINTIRE, J. M., dispersibility of spray-dried milk, 648*; determining ease of dispersion of milk powder, 648*
MCMULLAN, H. W., measurements of Jersey and Sindhi-Jersey cows, 1420
MCNEILL, J. J., nutritional requirements of rumen bacteria, 81; methane formation by rumen bacteria, 662*; effects of antibiotics on rumen bacteria, 1466

NAELAPAA, H., physiological response of bulls to extreme climatic conditions, 667*
NELSON, F. E., metabolism of amino acids by *L. casei*, 635*; factors affecting growth of psychrophilic bacteria, 636*; amino acids and peptides formed in milk by *S. lactis*, 790; extracellular peptidases of *S. lactis*, 795; action of aerosols on bacteriophage, 840; action of virucides on bacteriophage, 847; effects of storage temperatures on psychrophilic organisms, 1164
NELSON, J. H., use of ultrasonic waves in cheese ripening, 638*
NELSON, V., heat stability of evaporated milk, 825
NELSON, W. O., labor requirements for milk pipeline operation, 583; fatty acid specificity of microbial lipases, 646*
NEUBECK, C. E., enzymatic hydrolysis of lactose, 643*
NEVENS, W. B., yield and protein content of corn silage, 976; evaluation of corn silage, 1088
NEWLANDER, J. A., analysis of Vermont grass silages, 658*
NICKERSON, T. A., lactose crystallization in ice cream. I., 1099
NIEDERMEIER, R. P., sulfur dioxide preservation of legume silage, 52
NIELSEN, V. H., buffer capacities of skimmilk, buttermilk, and butter serum, 641*
NOLAND, J. E., digestibility of honeysuckle, 173

O'DELL, W. T., techniques for freezing spermatozoa, 652*
OHMS, J., trials with semen containing antibacterial agents, 649*
OKAMOTO, M., effect of supplemented milk diet on calves, 656*; results of feeding thyroprotein, 660*; hemoglobin levels in blood of calves, 805; cartilage width in normal and rachitic calves, 1220
OLAFSON, P., isolation of causative agent of hyperkeratosis from wheat concentrate, 662*
OLDS, D., longevity of spermatozoa in pasteurized milk, 650*; a study of bovine genitalia, 1158
OLSON, C., bull calves in the 4-H club program, 676*
OLSON, H. C., inhibitor for yeast and mold counts, 643*

ORMISTON, E. E., labor requirements for milk pipeline operation, 583
ORTHEY, A. E., effects of antibacterial agents on *V. fetus*, (1) added to semen extenders, 407; (2) in naturally infected semen, 416
OUTLER, J. C., availability of phosphorus, 661*
OWEN, F. G., response of calves to antibiotics and arsenicals, 654*

PARHAM, B. T., cottonseed meal, urea, and ammoniated molasses in rations, 657*
PATRICK, T. E., factors affecting fertility of bulls, 653*
PATTERSON, W., survey of production testing programs, 675*
PATTON, S., fat globule surface area and carotenoid and vitamin A content of milk, 147; mechanism of sunlight flavor formation in milk, 446; lactones and off-flavor of milk fat, 646*; effect of lactenin and lactoperoxidase upon spermatozoan livability, 1205
PEACE, E. J., utilization of colostrum for feeding calves, 655*
PERKINS, J. R., longevity of spermatozoa in pasteurized milk, 650*; a study of bovine genitalia, 1158
PETERSEN, W. E., effects of oxytocin-induced udder evacuation, 299; assay of cows' urine for pregnanediol, 355; ATP-ase activity in mammary particulate, 670*; effect of intervals between milking on production, 673*; technique of electroejaculation, 1035; effects of hourly milking with aid of oxytocin, 1261
PETTINATI, J. D., chromatographic study of milks, 538
PFAU, K. O., influence of dams and sires upon breeding efficiency of daughters, 667*
PICKETT, E. E., trace elements in whole milk, 643*; spectrographic determination of metals in milk products, 1401
PLASTRIDGE, W. N., cell counts of herd milk, 919
PLUM, M., relation of gestation period to birth weight of calves, 162
POITRAS, P. E., phosphorus requirements of bulls, 653*
POOS, F. W., feeding aldrin to cows, 294; excretion of dieldrin in milk, 1461
PORTER, A. R., effect of ground corn on grass silage, 658*
PORTER, G. H., effect of form of alfalfa on carotenoid and vitamin A content of milk, 311
POSTON, H. A., replacing hay with corn silage for cows, 657*
POUNDEN, W. D., volatile fatty acids in rumen of calves, 664*; effects of feeding aureomycin, 724
PRATHER, W. B., metabolic responses of spermatozoa to antibacterial agents, 228
PRATT, A. D., continuous vs. rotational grazing, 665*
PRITCHARD, G. I., effect of terramycin on growth of calves, 654*
PROUTY, C. C., changes in flora of cultured buttermilk during ripening, 1128

RAMSEY, H. A., effect of diet on calf plasma lipides, 1357
RAPP, H., influence of bulk handling raw milk on rennet coagulation time, 637*
REAVES, P. M., effect of ensiling on onion and ragweed flavors, 58
REECE, R. P., role of testis in mammary gland duct growth, 674*
REID, J. T., herbage selection by grazing cattle, 89
REINEKE, E. P., thyroxine content of thyroactive iodinated proteins, 1227
REISFELD, R. A., low-fat soft-ripened cheese, 639*
RHODE, C. S., appraising transmitting ability of sires, 245
RHODES, M. P., factors affecting cottage cheese quality, 637*
RICHARDS, C. T., lima bean silage, 658*
RICKARD, H. C., influence of mixed ejaculates upon fertility, 649*; activation of spermatozoa by sodium bicarbonate, 651*
RIDDELL, W. H., effect of terramycin on growth of calves, 654*
ROBERTS, H. R., chromatographic study of milks, 538
ROBERTS, W. M., measuring efficiency of labor utilization in milk plants, 642*; analysis of plant cleaning operations, 1198
ROBINSON, R. Q., aspartate dissimilation by rumen bacteria, 531; polysaccharide synthesis and lactic acid production by rumen bacteria, 662*
ROBRISH, S. A., carotene vs. vitamin A for feeding calves, 889
ROGERS, L. V., effect of xanthine oxidase on dairy products, 644*; baking quality of frozen condensed and dried skimmilk, 649*
ROLLERI, G. D., heat denaturation of milk serum proteins, 633*; changes in blood proteins associated with parturition, 662*
RONNING, M., phosphorus requirements of bulls, 653*
ROSS, E. B., milk replacement formulas for calves, 373
ROSS, R. H., undecorticated safflower meal for milk production, 671*
ROUSSEAU, J. E., JR., effect of vitamin A depletion on blood constituents, 857; carotene vs. vitamin A for feeding calves, 889; relationship between plasma and liver vitamin A in calves, 1376; estimation of vitamin A and carotenoids in calf liver, 1474
RUNYON, C. V., spectrographic determination of metals in milk products, 1401
RUSOFF, L. L., blood studies of breeding bulls, I, 30; parenteral administration of aureomycin to calves, 488; effect of aureomycin on blood constituents of calves, 654*; cottonseed meal, urea, and ammoniated molasses in rations, 657*; aureomycin and vitamin B_{12} supplementations for cows, 677
RUST, J. W., antibiotics for calves, 653*
RUTZ, W. D., milk viscosity as affected by homogenization, 642*; Reichert-Meissl numbers of Kansas butterfat, 646*

SAGER, O. S., factors affecting phosphatase test, 698
SAMPEY, J. J., enzymatic hydrolysis of lactose, 643*
SANDERS, G. P., factors affecting phosphatase test, 698
SAROFF, J., factors affecting survival of frozen spermatozoa, 651*; glycerol interference in staining spermatozoa, 652*, 1094
SAUNDERS, R. K., fiber digestion in miniature artificial rumen, 328
SAUTTER, J. H., effects of tocopherol on calves receiving filled milks, 655*
SCHULTZ, L. H., volatile fatty acids in the rumen of cows with ketosis, 644*
SCHWARTZ, D. P., lipases of raw skimmilk, 644*

SEATH, D. M., longevity of spermatozoa in pasteurized milk, 650*; effects of grass pasture grazing, 665*; a study of bovine genitalia, 1158
SEELEY, H. W., factor required by a rumen bacterium, 663*
SEIBERLING, D. A., automatization of dairy processing operations, 1019
SELL, O. E., gain by heifers on winter grazing crops, 1435
SENGER, M. E., weighing and sampling milk when pipelines are used, 675*
SGOURIS, J. T., antagonism between mammary growth and lactation, 669*
SHAFFHAUSEN, D. D., effect of relaxin upon milk ejection, I, 1173
SHAHANI, K. M., effect of heat on antibiotics in milk, 647*
SHAW, A. O., management practices and net returns in Washington, 14
SHAW, J. C., nutritional requirements of rumen bacteria, 81; aspartate dissimilation by rumen bacteria, 531; etiology and treatment of ketosis, 661*; effect of rumen bacteria on antibiotics, 663*; fat metabolism in mammary glands of cows, 924; effect of soybeans on plasma carotene and vitamin A of calves, 1269; effects of antibiotics on rumen bacteria, 1466
SHEURING, J. J., detecting substitute fats in ice cream, 647*
SIBBACH, E., estimation of lactose in dairy products, 10
SILVERMAN, G. J., heat processing curd into Mozzarrelle cheese, 639*; decarboxylation of amino acids in cheese, 645*
SIROTNAK, F. M., aspartate dissimilation by rumen bacteria, 531
SLATTER, W. L., factors affecting organic acid production of propionibacteria, 638*; free amino and fatty acids in Swiss cheese, 639*; effect of heat on antibiotics in milk, 647*
SMITH, E. P., effect of alfalfas on milk production, 657*
SMITH, J. T., maintenance of osmotic conditions during semen storage, 684
SMITH, L. M., unsaturated fatty acids of milk fat, I. methyl ester fractionation and monoethenoid constituents, 380; II. conjugated and nonconjugated constituents, 390; geometrical isomerism, 399
SMITH, Q. T., blood B-vitamin levels in calves fed aureomycin, 1190
SMITH, V. R., effect of oxytocin on milk and fat production, 195; blood constituents at parturition and after adrenocorticotrophin administration, 546; permeability of the gut of herbivores, 653*; leucocytes of cows with parturient paresis, 967; prenatal mortality in the bovine, 1071
SOMMER, H. H., fat separation in evaporated milk, I. homogenization, separation, and viscosity tests, 60; II. age thinning of concentrated, sterilized milk, 306; III. gravity separation and heat stability, 1061
SPECK, M. L., HTST pasteurization of ice cream mix, 37; stimulation of lactic acid bacteria, 634*; acetate–citrate metabolism of *S. lactis* and *S. cremoris*, 635*; nutrition of lactic acid bacteria, 635*
SPIELMAN, A. A., effects of vacuum level and milking duration, 276
SPRAIN, D. G., effect of oxytocin on milk and fat production, 195
SPROULE, W. H., effect of *G. candidum* on development of Cheddar cheese flavor, 637*
STAHLY, G. L., free amino compounds in starters, 645*
STALLARD, J. E., survey of production testing programs, 675*
STALLCUP, O. T., release of ammonia nitrogen by rumen microorganisms, 1449
STEIN, J. F., milk replacement formulas for calves, 373; 655*
STINE, C. M., peroxide test for lipid oxidation, 202
STODDARD, G. E., effects of varied rates of hay feeding, 1233
STONE, W. K., determining ease of dispersion of milk powder, 648*
STROBEL, D. R., filtration method for dry buttermilk solids, 631; freezing characteristics of homogenized and unhomogenized milk, 1416
STULL, J. W., stability of ascorbic acid in milk, 641*
SUNDARESAN, D., predicting lifetime production of Indian cattle, 1273
SWANSON, E. W., effects of feeding iodinated casein, 659*; effects of withdrawing thyroactive feed, 1212
SWETT, W. W., measurements of Jersey and Sindhi-Jersey cows, 1420
SWIFT, R. W., trials with sodium meta-bisulfite silage, 659*; characteristics of sodium metabisulfite silage, 659*
SYKES, J. F., alkaline phosphatase and glycogen in the uterus, 671*

TARASSUK, N. P., sedimentation rates of milk proteins, 633*; estimation of free fatty acids in rancid milk and cream, 646*
TAYLOR, J., effects of grass pasture(s) grazing, 665*
TEMPLETON, W., effects of grass pasture(s) grazing, 665*
THACKER, D. L., effect of milk proteins upon spermatozoan livability, 220; fertility of spermatozoa in heated milk, 1303
THOMAS, A., oxygen uptake by milk, 648*
THOMAS, J. W., effect of supplemented milk diet on calves, 656*; results of feeding thyroprotein, 660*; hemoglobin levels in blood of calves, 805; effects of thyroprotein feeding, 877; cartilage width in normal and rachitic calves, 1220
THOMAS, W. R., free fatty acid content of milk, 717
THOMPSON, N. R., grazing behavior of lactating cows, 665*; pastures for milk production, 666*
THROOP, B. T., alfalfa-orchard grass grazing, 664*
TITTSLER, R. P., survival and growth of Swiss cheese bacteria, 638*
TOUCHBERRY, R. W., yield and protein content of corn silage, 976; evaluation of corn silage, 1088
TOVE, S. B., effect of diet on calf plasma lipides, 1357
TOWNLEY, V. H., use of Venturi atomizer in spray drier, 647*
TRIMBERGER, G. W., influence of roughage on biochemical properties of milk, 1; utilization of molasses and urea in rations, 284; conception rates at intervals after parturition, 1042
TROUT, G. M., evaluation of student dairy product judging, 1021
TUMERMAN, L., protein stability in frozen concentrated milk, 830
TURK, K. L., influence of roughage on biochemical properties of milk, 1; utilization of molasses and urea in rations, 284

TURNER, C. W., stimulation of the rat mammary gland, 669*; causes of differences in productivity of cattle, 670*
TYLER, W. J., effect of oxytocin on milk and fat production, 195; factors affecting age at puberty in heifers, 252

ULBERG, L. C., fertilization rates and embryonic death rates, 691

VANDEMARK, N. L., factors affecting survival of frozen spermatozoa, 45; survival of sperm at sub-zero storage, 650*; effect of epinephrine on lactation in the rat, 670*
VAN DER ZANT, W. C., amino acids and peptides formed in milk by *S. lactis*, 790; extracellular peptidases of *S. lactis*, 795
VAN HORN, A. G., alfalfa-orchard grass grazing, 664*; effects of thyroprotein feeding, 877
VAN SOEST, P. J., levels of blood constituents in parturient cows, 185; effects of restricted roughage and high concentrate diets, 660*
VAN WINKLE, Q., changes induced in casein by *S. agalactiae*, 633*
VERNA, J. E., microflora of vulvo-vaginal mucosa, 671*
VIZINAT, J. J., physiological response of bulls to extreme climatic conditions, 667*
VOELKER, H. H., *in vivo* studies with surface-active agents, 737

WAGENAAR, R. O., effect of emulsifier on *C. botulinum*, 640*
WALKUP, H. G., management practices and net returns in Washington, 14
WALTER, W. G., coliforms from pasteurized milk, 636*
WARREN, F. S., lactation response to dehydrated and pelleted alfalfa, 523
WASSERMAN, B., microflora of vulvo-vaginal mucosa, 671*
WASSERMAN, R. H., factor required by a rumen bacterium, 663*
WASSUM, G. C., bulk milk dispenser operations, 642*
WATSON, G., dispersibility of spray-dried milk, 648*
WATTS, J. C., use of lyophilized lactic starter, 637*; preserving lactic starters by lyophilization, 639*
WAUGH, R. K., effect of management and housing on calves, 656*; replacing hay with corn silage for cows, 657*; effect of diet on calf plasma lipides, 1357
WECKEL, K. G., causes of hay flavor in vitamin A fortified low-fat milk, 1346
WEISBERG, S. M., manufacture and use of lactose, 1106
WEISER, H. H., free amino compounds in starters, 645*; effect of heat on antibiotics in milk, 647*; changes induced in casein by *S. agalactiae*, 633*
WERNER, G., practical methods of evaluating pastures, 676*
WHITAKER, W. M., alfalfa-orchard grass grazing, 664*
WHITE, R. F., fat globule surface area and carotenoid and vitamin A content of milk, 147
WHITEHEAD, H. R., growth characteristics of streptococcal phages, 209
WHITNAH, C. H., milk viscosity as affected by homogenization, 642*; Reichert-Meissl numbers of Kansas butterfat, 646*
WHITNEY, R. McL., effect of resin mixtures on skimmilk salts, 571
WILCOX, J. C., fatty acid specificity of microbial lipases, 646*
WILKOWSKE, H. H., lactic acid fermentation in reconstituted nonfat milk, 22; bacteriological studies of milk from menadione fed cows, 636*; assay of cheese for antibiotics, 1184
WILLETT, E. L., trials with semen containing antibacterial agents, 649*; laboratory tests for evaluating semen fertility, 1050; fertility of spermatozoa stored at 5° and −79° C., 1429
WILLIAMS, C., sulfur to nitrogen ratios in feeds, 813
WILLIAMS, S., outer-market distribution of milk in paper containers, 353
WILLINGHAM, J. J., determining total solids with the lactometer, 869
WILLMAN, H. A., 4-H dairy record keeping results, 676*
WILTBANK, J. N., fertilization rates and embryonic death rates, 691
WINDER, W. C., use of ultrasonic waves in cheese ripening, 638*; homogenization and deaeration of milk by ultrasonic waves, 645*
WINDHAM, E. S., freezing characteristics of homogenized and unhomogenized milk, 1416
WING, J. M., ensiling forages with citrus pulp, 658*
WINGERD, W. H., electrolytic deionization of protein-free whey, 932
WISE, G. H., effect of diet on calf plasma lipides, 1357
WISEMAN, H. G., use of acidifying salts in silage, 659*
WOLK, J., survival and growth of Swiss cheese bacteria, 638*
WOOD, K. R., determining ease of dispersion of milk powder, 648*
WOOD, W. A., fatty acid specificity of microbial lipases, 646*
WOOLFOLK, P. G., herbage selection by grazing cattle, 89
WRENN, T. R., alkaline phosphatase and glycogen in the uterus, 671*

YAGER, R. H., freezing characteristics of homogenized and unhomogenized milk, 1416
YAMIN-SMITH, M. L., fat metabolism in mammary glands of cows, 924
YOUNG, G. F., fertility of spermatozoa stored at 5° and −79° C., 1429

ZAKARIASEN, B. M., determining total solids with the lactometer, 869; fortification of skimmilk with nonfat dry milk solids for cottage cheese, 637*
ZEHNER, C. E., sulfur dioxide preservation of legume silage, 52
ZEHREN, V. L., growth characteristics of streptococcal phages, 209

SUBJECT INDEX OF ORIGINAL ARTICLES

ACID PRODUCTION, by propionibacteria, factors affecting, 638*
Acidifying salts, in high moisture hay crop silage, use of, 659*
Acidity, titratable, and pH during lactic fermentation of nonfat milk, 22
Activity-time relationship, specific, in tracer studies of milk secretion, 670*
Adrenal, histology of, in relation to reproduction, 1074
Adrenocorticotrophin, constituents of blood after administration of, 546
Adsorbed materials, on milk fat globule, effect of heat on, 644*
Adulteration, of milk fat, detection of, 646*
Aesosols, of viricides, effect on bacteriophage, 840
Age, at first calving,
  type score as related to, 666*
  used to predict life-time production of Indian cattle, 1273
  at puberty, in Holstein heifers, factors affecting, 252
  calving, and intervals between successive calvings, 672*
Agglutination test, in study of vulvo-vaginal mucosa microflora, 671*
Aldrin, fed to cows, studies of, 294
Alfalfa,
  dehydrated and pelleted, effect on lactation response, 323
  ensiled, milk production as affected by maturity of, 247
  hays, feeding value of, 1116
  various forms of,
    effect on carotenoid and vitamin A content of milk, 311
    effect on milk production, 657*
Alfalfa-orchard grass, grazing results with, 664*
American Dairy Science Association, proposed public relations, objectives of, 769
Amino acid, metabolism by *L. casei*, 635*
Amino acids,
  free,
    in foreign type cheese, appraisal of, 167
    in Swiss cheese, 639*
  in Cheddar cheese, decarboxylation products of, 645*
  in milk, formed by action of *S. lactis*, 790
Amino compounds, free, in starters, chromatographic analysis of, 645*
Ammonia nitrogen, released by rumen microorganisms, 1449
Ammoniated molasses,
  ammonia nitrogen released by rumen microorganisms from, 1449
  vs. urea vs. cottonseed meal in ration, 657*
Amylases, milk, characterization of, 644*
Androgens, fecal, analysis of errors in assaying, 72
Anemia, in calves, alleviation by iron, 805
Antagonism, between mammary growth and lactation, 669*
Anthrone, estimation of lactose by use of, 10
Antibacterial agents,
  in semen, field trials with, 649*
  metabolic responses of spermatozoa to, 228
Antibiotic activity, of mold-ripened cheeses, 1184
Antibiotic feeding, to cattle, long-time effects of, 657*
Antibiotic supplementation, response of calves to, 654*
Antibiotics,
  for calves, value of combination vs. single, 653*
  in milk, effect of heat on, 647*
Antioxidants, fed to calves, results of, 654*
Apyrase activity, of the mammary gland, 498
Arsenical supplementation, response of calves to, 654*
Artificial breeding,
  condition of cows at time of, 672*
  fertilization and embryonic mortality rates for bulls in, 649*
  influence of fertility level and treatment of semen on nonreturn decline following, 938
  interrelationships among factors affecting bulls in, 653*
  relationship between number of services and per cent nonreturns, calving rates and sex ratio in, 673
Ascorbic acid, in milk, effect of treatments on stability of, 641*
Aspartate dissimilation, by rumen bacteria, 531
Association announcements,
  call for papers for 50th annual meeting, 1473
  49th annual meeting, 119; 462
  information for authors, 103
  letter from president of Pennsylvania State University, 119
  membership directory, 125
  officers and committees of A.D.S.A., 121
  proceedings of 49th annual meeting, 990
  program for 49th annual meeting, 593
  section officers for 49th annual meeting, 120
  section officers for 50th annual meeting, 1473
ATP-ase activity, in lactating bovine mammary particulate, 670*
Aureomycin,
  effect of rumen bacteria on potency of, 663*
  effect on B-vitamins in blood of calves, 1190
  effect on blood constituents of calves, 654*
  effect on calves, 259, 724, 982
  effect on in vitro cellulose digestion by rumen microorganisms, 663*
  effect on production, composition, and vitamin B_{12} content of milk, 677
  effect on rumen bacteria, 1466
  for yeast and mold counts, use of, 643
  parenterally administered to calves, 488
Authors, information for, 103
Automatization, of dairy processing operations, 1019
Ayrshires, genetic analysis of components of type and production in, 667*

BABCOCK test, for milk, standardized procedures for, 761
Bacteria,
  cellulolytic, of the bovine rumen, 1176
  lactic acid,
    corn steep liquor in nutrition of, 635*
    stimulation of, 634*
  psychrophilic,
    destruction rate of, in skimmilk, 317
    factors affecting growth of, 636*
    growth in skimmilk as affected by temperatures, 1164

* Abstract of paper presented at the annual meeting.

rumen,
aspartate dissimilation reactions of, 531
effect of aureomycin and terramycin on, 1466
effect on potency of aureomycin and terramycin, 663*
formation of methane by, 662*
nutritional requirements of, 81
polysaccharide synthesis and lactic acid production by, 662*
Swiss cheese, factors affecting survival and growth of, 638*
Bacterial population, of milk, changes in as affected by bactericides, 635*
Bactericides, chemical, effects on milk flora, 635*
Bacteriological studies, on HTST pasteurization of ice cream mix, 37
Bacteriophage, for lactic streptococcus,
action of viricides on, 847
effect of viricidal aerosols on, 840
Baking quality, of frozen condensed and dried skimmilk, 649*
Benzoyl peroxide, in bleaching milk, factors affecting action of, 1241
β-hydroxybutyric acid, metabolism by mammary gland, 669*
Birth weight, of Holstein calves, relation of gestation length to, 162
Blackish, in cattle, inheritance of, 1368
Blood, calf, hemoglobin levels in, 805
Blood constituents,
at parturition and after administration of adrenocorticotrophin, 546
calf,
effect of aureomycin on, 654*
effect of vitamin A depletion rations on, 857
in normal calving and cows with parturient paresis, levels of, 185
Blood plasma, calf,
carotene and vitamin A of, 1269
effects of diets on lipides in, 1357
Blood studies, of breeding bulls, 30
Body weight,
effect of rate of hay feeding on, 1233
effect of withdrawing thyroactive feed on, 1212
Body weights and measurements,
of Jersey and Sindhi-Jersey females, 1420
Bovine genitalia, a study of, 1158
Brazil, reproductive rates and growth of Brown Swiss cattle in, 1145
Breeding efficiency,
as related to number of gestations, 673*
influence of dams and sires upon, 667*
Breeding results, with spermatozoa frozen in milk, 652*
Bridge of Life, dairyman's, 674*
Brown Swiss cattle, in Brazil, reproductive rates and growth of, 1145
Brucella abortus, in milk,
thermal death time of, 636*, 1291
Brucellosis, 1141
Buffer capacities, of skimmilk, buttermilk, and butter serum, 641*
Buildings, dairy farm, design and construction of, 1392
Bulk milk dispenser operations, plant study of, 642*
Bulk milk handling,
and pipeline milking, 1486
influence on rennet coagulation time, 637*
Bull calves, and the 4-H Club program, 676*
Bulls,
appraising transmitting ability of, 245
breeding, blood studies of, 30
effect of climatic conditions on, 667*
effect of dehydrated grass on reproductive efficiency of, 1123
electroejaculation of, 556, 1035, 1439. 1444
fertilization and embryonic mortality rates for, 649*
histology of pituitary, testis, and adrenal related to production in, 1074
laboratory tests for evaluating fertility of, 1050
rations for study of phosphorus requirements of, 653*
Butter, report of the ADSA committee on, 590
Butterfat,
influence of oxytocin-induced udder evacuation on, 299
in Kansas, Reichert-Meissl numbers of, 646*
Butterfat production,
comparison of approximate indexes for, 668*
effect of intervals between milking on, 673*
Buttermilk,
buffer capacities of, 641*
cultured, bacteriological studies of, 1128
solids, roller process dry, filtration method for, 631
Butteroil, effect of antioxidative properties of cacao on, 754
Butter serum, buffer capacities of, 641*
Butyric acid, detection of substitute fats in dairy products by measurement of, 481

CACAO, antioxidative properties of, 754
Calcium,
dietary, incidence of milk fever as affected by, 360
salts, in casein sols, activity of, 634*
Calcium borogluconate, effect on blood and urinary calcium in cows with parturient paresis, 661*
Calves,
antibiotic and arsenical supplementation for, 654*
antibiotics, combination vs. single for, 653*
antioxidants fed to, 654*
aureomycin fed to, 259, 488, 724, 982
blood constituents of, effect of vitamin A depletion rations on, 857
bull, and the 4-H club program, 676*
B-vitamin levels in blood of, 1190
carotene vs. vitamin A for feeding of, 889
colostrum in feeding of, 655*
dietary factors affecting blood serum magnesium of, 656*
effect of management and housing on growth and health of, 656*
fat-free diets for, 453
fed filled milks, effects of tocopherol on, 655*
fed high roughage, volatile fatty acid content of rumen juice and blood sugar levels in, 664*
fed low intake of carotene or vitamin A, plasma and liver Vitamin A of, 1376
hemoglobin levels in blood of, 805
high roughage system for, 512
Holstein, relation of gestation length to birth weight of, 162
liver, vitamin A and carotenoids in, 1474
normal and rachitic, ulnar epiphyseal cartilage width in, 1220
outdoor pens vs. conventional housing for, 562
plasma carotene and vitamin A of, 1269
plasma lipides of, effect of diets on, 1357
soybean flour and whey solubles in milk replacement formulas for, 373, 655*

supplemented whole milk diet for, 656*
surface-active agents fed to, 737
terramycin fed to, 654*
Calving age, and intervals between successive calvings, 672*
Calving rates, and sex ratio in artificial breeding, 673*
Carotene,
in plasma of calves fed soybeans, 1269
plasma and liver vitamin A in calves fed minimum levels of, 1376
vs. vitamin A, for calf feeding, 889
Carotenoid content of milk, 147, 311
Carotenoids, and vitamin A in calf liver, estimation of, 1474
Casein, iodinated, using identical twin cows to determine effects of, 659*
Casein, *S. agalactiae*, induced changes in, 633*
Casein sols, activity of salts in, 634*
Cattle,
antibiotics in nutrition of, 259
Brown Swiss, reproductive rates and growth in Brazil, 1145
causes of differences in productivity of, 670*
conception rates from services at intervals after parturition, 1042
genetic variation and covariation in rate of maturity and level of production in, 668*
grazing, degree of herbage selection by, 89
Indian, predicting life-time production of, 1273
influence of dietary calcium and phosphorus on incidence of milk fever in, 360
inheritance of blackish in, 1368
lima bean silage for, 658*
long-time effects of antibiotic feeding to, 657*
molasses and urea in rations of, 284
pangola-white clover pastures for, 666*
Richardson biochemical pregnancy test applied to, 662*
selection index for fat production in, 744
Cell counts, of platform samples of herd milk, 919
Cellulose digestion, in vitro, effect of aureomycin on, 663*
Cheese,
blue,
bleaching milk and cream with benzoyl peroxide for manufacture of, 1241
microflora of the slime of, 436
Cheddar,
decarboxylation products of amino acids in, 645*
effect of *G. candidum* on flavor development in, 637*
cottage,
effect of fortification of fluid skimmilk with nonfat dry milk solids on yield of, 637*
factors affecting quality of, 637*
slime formation on, 176
use of lyophilized starter in, 637*
cream, manufacture of, 243
Exchange, Wisconsin, 909
foreign type, appraisal of free amino acids in, 167
growth characteristics of streptococcal phages in relation to manufacture of, 209
low-fat soft-ripened, 639*
making, white mutants of *P. roqueforti* used in, 711
mold-ripened, antibiotic activity of, 1184
Mozzarelle, heat processing of Italian curd into, 639*
ripening, use of ultrasonic waves for acceleration of, 638*
surface-ripened, effect of emulsifier on *C. botulinum* in, 640*
Swiss,
factors affecting acid production by propionibacteria used in, 638*
free amino and fatty acids in, 639*
Chelating compounds, inhibition of oxidized flavor of milk with, 819
Chromatography,
ion-exchange, measurement of free amino compounds in starters by use of, 645*
paper, carbohydrate constituents of milks detected by, 538
Chromic oxide, factors affecting diurnal excretion pattern of, 672*
Citrus pulp, dried, ensiling pasture forages with, 658*
Cleaning operations, milk plant, methods-time measurement, analysis of, 1198
Climate, simulated subtropical, response of bulls to, 667*
Clostridium botulinum, in cheese, effect of emulsifier on, 640*
Coconut oil, hydrogenated, calf digestion coefficient for, 453
Coliforms, isolated from pasteurized milk, 636*
College graduates, in the dairy industry, recruitment and training of, 116
Colostrum,
as a substitute for milk in a limited whole milk feeding system, 655*
utilized for feeding calves, 655*
Concentrated (fresh) milk, 647*
Conception rates, from services at intervals after parturition, 1042
Copper, in milk, quantitative spectrographic determination of, 1401
Copper salts, effect on heat stability of evaporated milk, 825
Corn forage, ear and leaf-stalk contents as factors in evaluation of silage from, 1088
Corn, ground, composition and palatability of grass silage as affected by addition of, 658*
Corn products, dietary, as related to concentration of magnesium in serum of calves, 656*
Corn silage,
effect of fertilization on yield and protein content of, 976
effect on lactating cows of replacing hay with, 657*
nutritive value for milking cows, 957
Corn steep liquor, in nutrition of lactic acid bacteria, 635*
Cottonseed meal, vs. urea vs. ammoniated molasses in ration, 657*
Counts, yeast and mold, use of aureomycin for, 643*
Cows,
activities of, in loose-housing, 269
aldrin fed to, 294
at time of artificial breeding, condition of, 672*
aureomycin and vitamin B_{12} supplementations for, 677
bred to bulls of different levels of fertility, fertilization rates and embryonic death rates in, 691
breeding efficiency as related to number of gestations of, 673*
calving normally and with parturient paresis, levels of blood constituents in, 185
effect of potassium iodide on levels of protein bound iodine in, 660*
effect of wind on, 674*

etiology and treatment of ketosis in, 661*
fecal androgens in, 72
fed dieldrin-sprayed forage, excretion of dieldrin in milk of, 1461
lactating,
as affected by replacement of hay with corn silage, 657*
effect of rate of hay feeding on body weight and production of, 1233
histochemical studies of fat metabolism in mammary glands of, 924
on pasture, grazing behavior of, 665*
menadione fed, bacteriological studies of milk from, 636*
milking,
effects of thyroprotein on, 877
nutritive value of corn silage for, 957
response to management following parturition of, 673*
sulfur:nitrogen in feeds for, 813
twin, identical, used to determine effects of iodinated casein, 659*
with ketosis, volatile fatty acids in rumen of, 664*
with parturient paresis,
effect of calcium borogluconate on blood and urinary excretion levels of calcium in, 661*
leucocytes of, 967
Cream,
factors affecting action of benzoyl peroxide in bleaching of, 1241
methods for estimation of free fatty acids in, 646*
Crossbred females, Jersey and Sindhi-Jersey, measurements of, 1420

DAIRY FARM buildings, design and construction of, 1392
Dairy industry,
guideposts for, 352
recruitment and training college graduates in the, 116
role in utilizing our resources, 472
Dairy processing operations, automatization of, 1019
Dairy products,
detection of foreign fats in, 156, 481
effect of xanthine oxidase on, 644*
judging of, evaluation of student, 1019
lactose in, estimation of, 10
peroxide test for lipid oxidation in, 202
xanthine oxidase content of, 644*
Dairy research to the rescue, 912
Dairy surpluses, problem of, 113
Dairy technologists, training of, 1397
Dairyman's "bridge of life," 674*
Decarboxylation, of amino acids in Cheddar cheese, 645
Deionization, electrolytic, of protein-free whey, 932
Demonstrations, in teaching dairy science, 345
DHIA forms, presentation and discussion on changes of, 676*
DHIA herds,
New York production and feeding analysis for, 675*
source of nutrients and their effects on production in, 675*
Dicyanodiamide, in rations, value of, 657*
Dieldrin, in milk of cows fed sprayed forage, 1461
Diet, restricted roughage–high concentrate, effect on milk fat, blood glucose and ketones, 660*
Diets, various, effects on plasma lipides of calves, 1357
Differential staining, of spermatozoa, interference by glycerol with, 652*
Digestibility, of dry matter in winter forages, 1435
Digestibility indicator, method of using plant pigments as, 672*
Digestibility studies, with grazing animals, 665*
Digestion, of fiber, in miniature artificial rumen, 328
Diluents, egg yolk, ability to maintain osmotic conditions during semen storage, 684
Diluters, semen,
frozen skimmilk as, 650*
heated milk and egg yolk–citrate as, 1308
recovery of frozen spermatozoa as related to composition of, 652*
survival of frozen spermatozoa as related to composition of, 651*
Dispersion, of milk powder, method for determining ease of, 648*
Dry matter intake, by grazing animals, 665*

EFFICIENCY, of labor utilization in milk plants, measurement of, 642*
Egg yolk–citrate, and heated milk, as semen diluters, 1308
Ejaculates, mixed, influences upon fertility, 649*
Electroejaculation, technique and use in bulls, 556, 1035, 1439, 1444
Embryonic death rates, in cows bred to bulls of different levels of fertility, 691
Emulsifier, in cheese, effect on *C. botulinum*, 640*
Ensiling process, effect on onion and ragweed flavors in silage and milk, 58
Enzymes,
lipolytic, of raw skimmilk, 644*
proteolytic, stimulation of lactic acid bacteria by substances concomitant to, 634*
Epinephrine, effect on lactation in the rat, 670*
Erythrocyte count, of bull blood, 30
Estrogen, effect on distribution of alkaline phosphatase and glycogen in the uterus, 671*
Evaporated milk,
effect of storage on concentration of metals in, 1401
effects of formaldehyde and copper on heat stability of, 825
fat separation in:
age-thinning of concentrated, sterilized milk, 306
gravity separation and heat stability, 1061
homogenization, separation, and viscosity tests, 60
Excretion pattern, diurnal, of chromic oxide, 672*
Extenders, revival rate of frozen spermatozoa in, 651*
Extension programs, use of television in, 674*

FARM buildings, dairy, design and construction of, 1392
Fat,
and milk production, effect of oxytocin on, 195
dietary requirements of calves for, 453
Fat-free diets, effect on calves, 453
Fat globule,
carotenoid and vitamin A content of milk as related to surface area of, 147
effect of heat on materials adsorbed on, 644*
in structure of ice cream, identification of, 642*

Fat metabolism, in mammary glands, hsitochemical studies of, 924
Fat percentage, genetic covariation between milk yield and, 668*
Fat production,
in cattle, selection index for, 744
type score as related to, 666*
Fat separation, in evaporated milk:
age-thinning of concentrated, sterilized milk, 306
gravity separation and heat stability, 1061
homogenization, separation, and viscosity tests, 60
Fats, foreign, in dairy products, detection of, 156, 481, 647*
Fatty acids, specificity of microbial lipases for, 646*
Fatty acids, free,
in fresh milk as related to portions of milk drawn, 717
in milk and cream, methods for estimation of, 646*
in Swiss cheese, 639*
Fatty acids, unsaturated, of milk fat,
conjugated and nonconjugated constituents, 390
geometrical isomerism, 399
methyl ester fractionation and monoethenoid constituents, 380
Fatty acids, volatile,
in rumen juice of calves, influence of ration on, 664*
in rumen of cows with ketosis, 664*
Fecal androgens, analysis of, 72
Fecal fat, metabolic, observations on, 453
Feces, yields and composition of holocellulose prepared from, 664*
Feeds,
for cows, sulfur: nitrogen in, 813
yields and composition of holocellulose prepared from, 664*
Fermentation, lactic, in reconstituted nonfat milk, 22
Fertility,
and semen production of bulls ejaculated at various intervals, 1439, 1444
influences of mixed ejaculates upon, 649*
of semen and bulls, laboratory tests for evaluation of, 1050
of spermatozoa in heated milks, 1303
of spermatozoa stored at 5° C. and −79° C., 1429
related to number of spermatozoa inseminated, 1353
with frozen spermatozoa, 651*
Fertilization, yield and protein of silage corn as influenced by, 976
Fertilization rates,
for bulls in artificial breeding, 649*
in cows bred to bulls of different levels of fertility, 691
Fiber, in miniature artificial rumen, digestion of, 328
"Filled milk," for veal production, butyrated lard in, 431
Filtration method, for roller process dry buttermilk solids, 631
Flavor,
coconut-like, of milk fat, lactones responsible for, 646*
onion and ragweed, in milk and silage, effect of ensiling process on, 58
Fly control, in dairy processing plants, 348
Food packaging, trends in, 1251
Forage,
corn, ear and leaf-stalk as factors in silage evaluation, 1088
dieldrin-sprayed, excretion of dieldrin in milk of cows fed on, 1461
winter, dry matter digestibility of, 1435
vitamin D content of, 1337
Formaldehyde, effect on heat stability of evaporated milk, 825
4-H (club),
dairy record keeping results, 676*
members, encouraged to keep production records, 676*
program, bull calves in the, 676*
Freezing characteristics, of homogenized and unhomogenized milk, 1416

GENETIC analysis, of components of type and production in Ayrshires, 667*
Genetic covariation, between milk yield and fat percentage, 668*
Genetic variation and covariation, in rate of maturity and level of production in cattle, 668*
Genitalia, bovine, a study of, 1158
Geotrichum candidum, effect on flavor development in Cheddar cheese, 637*
Germicides, in sanitizing teat cup inflations, effect of, 640*
Gestations,
relation of birth weights of calves to length of, 162
relation of breeding efficiency to number of, 673*
Glucose, blood, effect of restricted roughage-high concentrate diet on, 660*
Glucose-C^{14}, spermatozoan uptake of, 425
Glycerol,
interference with differential staining of spermatozoa, 1094
survival of frozen spermatozoa as affected by level of, 45
Glycogen, effect of estrogen and progesterone on uterine distribution of, 671*
Grass, dehydrated, effect on reproductive efficiency of bulls, 1123
Grass silage,
composition of, 1273
in Vermont, composition and nutrient value of, 658*
legume, effect of ground corn on composition and palatability of, 658*
made with sodium-metabisulfite, chemical characteristics of, 659*
preserved with sodium metabisulfite, field trials with, 659*
Grazing, continuous vs. rotational, 665*
Grazing animals, dry matter intake and digestibility studies with, 665*
Grazing behavior, of lactating cows on pasture, 665*
Grazing crops, winter, forage dry matter digestibility and weight gain by heifers on, 1435
Grazing results, with alfalfa-orchard grass, 664*
Growth, and function of rat mammary gland, stimulation of, 669*
Growth characteristics, of streptococcal phages, in relation to cheese manufacture, 209

HAY,
alfalfa, feeding value of, 1116
feeding, body weight and milk production affected by rates of, 1233

grain ratios, fed with aureomycin to calves, effects of, 724
replaced by corn silage, effect on lactating cows, 657*
test for quality in, 552
Hay-like flavor, in vitamin A fortified low-fat milk, 1346
Heat denaturation, of milk serum proteins, 633*
Heat stability, of evaporated milk, effects of formaldehyde and copper on, 825
Heifers,
Holstein, factors affecting age at puberty in, 252
on winter grazing crops, weight gain of, 1435
Hematocrit values, of bull blood, 30
Hemoglobin,
levels, in blood of calves, 805
values, in bull blood, 30
Herbage, selection, by grazing cattle, 89
Herbivore, newborn, permeability of the gut of, 653*
Herd, dairy, fed on farm grown materials, 905
Holocellulose, prepared from feeds and feces, yields and composition of, 664*
Holstein-Friesian herd, influence of dams and sires on breeding efficiency of daughters in a, 667*
Homogenization,
and deaeration of milk, by ultrasonic waves, 645*
viscosity of milk as affected by, 642*
Honeysuckle, for yearling bulls, digestibility of, 173
Housing,
effect on growth and health of calves, 656*
for calves, conventional vs. outdoor pens, 562
Hyperkeratosis (X-disease), isolation and identification of causative agent from processed wheat concentrate, 662*

ICE CREAM,
detection of substitute fats in, 647*
identification of fat globules in structure of, 642*
increasing solids-not-fat in, 643*
seeding to control lactose crystallization in, 1099
Ice cream mix, bacteriological studies on HTST pasteurization of, 37
Indexes, approximate, for butterfat production, comparison of, 668*
Inheritance, of blackish in cattle, 1368
Inorganic equilibria, in milk, ion-exchange resin-contact time method for study of, 1409
Iodine, protein bound, effect of feeding potassium iodide on, 660*
Ion-exchange resin-contact time method, inorganic equilibria in milk studied by, 1409
Ionic availability, in milk, effect of heat on, 643*
Iron,
alleviation of anemia in calves by use of, 805
in milk, quantitative spectrographic determination of, 1401
Isotope dilution technique, thyroxine determined by, 1227
Italian curd, for Mozzarrelle cheese, heat processing of, 639

JERSEY females, body weights and measurements of, 1420
Judging dairy products, student, evaluation of, 1019

KETONES, blood, effect of restricted roughage–high concentrate diet on, 660*
Ketosis,
etiology and treatment of, 661*
volatile fatty acids in rumen of cows with, 664*
Knowledge, Dairymen's, influence on success, 1255
Kreis reaction, compounds in oxidized milk fat responsible for, 647*

LABOR,
requirements, for milk pipeline and conventional milking operations, 583
utilization, in market milk plants, method for measuring efficiency of, 642*
Lactation,
antagonism between mammary growth and, 669*
rat, effect of epinephrine on, 670*
response, effect of dehydrated and pelleted alfalfa on, 523
Lactenin, effect on spermatozoan livability, 1205
Lactic acid
bacteria,
corn steep liquor in nutrition of, 635*
stimulation of, 634*
production, by rumen bacteria, 662*
starter cultures, free amino compounds in, 645*
Lactic starters, preserved by lyophilization, 639*
Lactobacilli, in milk, characterization of, 634*
Lactobacillus casei, metabolism of amino acids by, 635*
Lactometer, determining milk solids by use of, 869
Lactones, and the coconut-like off-flavor of milk fat, 646*
Lactoperoxidase, effect on spermatozoan livability, 1205
Lactose,
in dairy products, estimation of, 10
process for enzymatic hydrolysis of, 643*
progress in manufacture and use of, 1106
Lactose crystallization,
effect on protein stability in frozen concentrated milk, 830
in ice cream, controlled by seeding, 1099
Lard,
butyrated, in "filled milk" for veal production, 431
calf digestion coefficient for, 453
Lead, in milk, quantitative spectrographic determination of, 1401
Lespedeza sericea, factors affecting apparent nutritional value of, 666*
Letters to the editor, 111, 240, 343, 466, 621, 904, 1138, 1483
Leucocytes,
of bull blood, 30
of cows with parturient paresis, 967
Leuconostoc citrovorum, in cultured buttermilk, changes in numbers of, 1128
Lima bean silage, for cattle, 658*
Lipase: A review, 775
Lipases,
of raw skimmilk, 644*
microbial, fatty acid specificity of, 646*
Lipid oxidation, peroxide test for, 202
Lipides, plasma, of calves, effects of diets on, 1357
Livability, spermatozoan, as affected by milk proteins, 220
Liver, calf, estimation of vitamin A and carotenoids in, 1474

Liver vitamin A, as related to plasma vitamin A in calves, 1376
Loose-housing, cow activities in, 269
Lyophilization, preservation of lactic starters by, 639*

MAGNESIUM, serum, of calves, dietary factors affecting, 656*
Malty aroma substance, from cultures of *S. lactis* var. *maltigenes*, identity of, 1316
Mammary gland,
apyrase activity of, 498
β-hydroxybutyric acid metabolism of, 669*
duct, role of testis in growth of, 674*
extracts, biological activity of phosphate esters in, 1027
growth, antagonism between lactation and, 669*
histochemical studies of fat metabolism in, 924
phosphokinase activity of, 505
rat, stimulation of growth and function of, 669*
Mammary particulate, bovine, lactating,
ATP-ase activity in, 670*
oxidative metabolism in, 671*
Management,
effect on growth and health of calves, 656*
effect on response of cows following parturition, 673*
practices, and net returns in Washington milk production, 14
Maturity rate, in cattle, genetic variation and covariation in, 668*
Menadione, dietary, effect on susceptibility of milk to copper-induced oxidized flavor, 640*
Menadione-fed cows, bacteriological studies of milk from, 636*
Metabolism,
acetate–citrate, of lactic group streptococci, 635*
amino acids, by *L. casei*, 635*
β-hydroxybutyric acid, of the mammary gland, 669*
fat, of mammary glands, histochemical studies of, 924
oxidative, in lactating bovine mammary particulate, 671*
Metals, in evaporated milk, effect of storage on, 1401
Methane, formation by rumen bacteria, 662*
Methionine, and sunlight flavor formation in milk, 446
Methods-time measurement analysis, of milk plant cleaning operations, 1198
Microflora,
of blue cheese slime, 436
of the vulvo-vaginal mucosa, agglutination test in study of, 671*
Microorganisms, rumen,
effect of aureomycin on in vitro cellulose digestion by, 663*
release of ammonia nitrogen by, 1449
Milk,
amylases in, 644*
and food sanitation, laboratory training in, 1484
biochemical properties of, 1
buffer capacities of, 641*
cell counts of platform samples of, 919
dispenser operations, bulk, plant study of, 642*
effect of:
bactericides on flora of, 635*
benzoyl peroxide in the bleaching of, 1241
ensiling process on onion and ragweed flavors in silage and, 58
form of alfalfa on carotenoid and vitamin A content of, 311
heat on antibiotic content of, 647*
homogenization on viscosity of, 642*
S. lactis on amino acid and peptide content of, 790
treatments on stability of ascorbic acid in, 641*
ejection, of sheep, effect of relaxin on, 1173
fat,
detection of adulteration of, 646*
effect of restricted roughage—high concentrate diet on, 660*
lactones and the coconut-like off-flavor of, 646*
oxidized, compounds producing Kreis and thiobarbituric acid reactions in, 647*
unsaturated fatty acids of,
conjugated and nonconjugated constituents, 390
geometrical isomerism, 399
methyl ester fractionation and monoethenoid constituents, 380
filled, effects of tocopherol on calves fed various types of, 655*
flow, effects of vacuum level and milking duration on rate of, 276
fortification of, 624
free fatty acids in, 646*
fresh,
concentrated, flavor of, 647*
free fatty acid content related to portions drawn, 717
from cows fed dieldrin-sprayed forage, excretion of dieldrin in, 1461
from cows fed menadione, bacteriological studies of, 636*
from successive portions of a milking, relationship between fat globule surface area and carotenoid and vitamin A content of, 147
frozen concentrated, effect of lactose crystallization on protein stability of, 830
handling, bulk, and pipeline milking, 1486
heated,
and egg yolk–citrate, as semen diluters, 1308
fertility of spermatozoa in, 1303
homogenized,
and deaerated by ultrasonic waves, 645*
freezing characteristics of, 1416
human, cow, sow, and rat, comparative study of carbohydrates in, 538
inorganic equilibria in, 1409
in paper containers, outer market distribution of, 353
lactobacilli found in, 634*
nonfat,
manufacture of, 476
reconstituted, lactic fermentation in, 22
oxidized flavor of, 641*, 819
oxygen uptake by, 648*
pasteurized,
coliforms isolated from, 636*
inoculated with *G. candidum* for cheese manufacture, 637*
longevity of spermatozoa in, 650*
plant cleaning operations, methods-time measurement analysis of, 1198
plants, market, method for efficiency of labor utilization in, 642*
powder,
method for determining ease of dispersion of, 648*

spray-dried, manufacturing conditions affecting dispersibility of, 648*
wettability method for, 863
production,
and profit, as influenced by farm grown feeds, 905
effect of aureomycin and vitamin B_{12} supplementation on, 677
effect of intervals between milking on, 673*
effect of maturity of ensiled alfalfa on, 247
effect of oxytocin on, 195
effect of rate of hay feeding on, 1233
effect of thyroprotein feeding on, 877
effect of vacuum level and milking duration on, 276
effect of various forms of alfalfa on, 657*
effect of withdrawing thyroactive feed on, 1212
influence of grass pastures on persistency of, 665*
influence of oxytocin-induced udder evacuation on, 299
in Washington, management practices and net returns in, 14
prediction of, 1273
undecorticated safflower meal and protein content of grain for, 671*
various pastures for, 666*
products, promoting use of, 467
proteins,
effect of heat and salts on sedimentation rates of, 633*
effect on spermatozoan livability, 220
sedimentation of, 634*
serum, heat denaturation of, 633*
raw, rennet coagulation time of, as influenced by bulk handling, 637*
replacement diet, with and without aureomycin, effect of, on calf blood, 1190
replacement formulas, use of soybean flour and whey solubles in, 373, 655*
sanitation,
laboratory training program in, 1484
survey of, 1399
secretion, specific activity-time relationship in studies of, 670*
skim (see Skimmilk)
solids, determination by use of lactometer, 869
spectrographic analysis of trace elements in, 643*
sunlight flavor formation in, 446
supplemented with known nutrients, effect on calves, 656*
thermal death time studies of *B. abortus* in, 636*, 1291
unhomogenized, freezing characteristics of, 1416
vitamin A fortified, hay-like flavor in, 1346
yield, genetic covariation between fat percentage and, 668*
Milk fever, influence of dietary calcium and phosphorus on incidence of, 360
Milking,
at various intervals, effect on production, 673*
duration, effects on production, milking time and rate, 276
with aid of oxytocin, effects of, 1261
Milkstone formation, laboratory study of, 640*
Molasses, and urea, in rations of growing cattle, utilization of, 284
Mold-ripened cheeses, antibiotic activity of, 1184
Mortality,
prenatal, between pregnancy diagnosis and parturition, 1071
rates, embryonic, for bulls in artificial breeding, 649*
Mutants, white, of *P. roqueforti*, use in cheese making, 711

NET RETURNS, and management practices in Washington milk production, 14
Nitrogen extender, in rations, value of dicyanodiamide as, 657*
Nitrogen: sulfur ratios, in feeds for cows, 813
Nonfat milk,
manufacture of, 476
reconstituted, lactic fermentation in, 22
Nonreturn decline, 938, 959
Nonreturns, relationship between number of services and per cent of, 673*
Nutrition information, on promoting use of milk products, 467
Nutritional requirements, of rumen bacteria, 81
Nutritive value, of corn silage, 957

OSMOTIC conditions, optimum, for semen, egg yolk diluents for maintenance of, 684
Oxidized flavor, of milk,
copper-induced, inhibitory effect of menadione on, 640*
factors affecting, 641*
inhibition with chelating compounds, 819
Oxygen uptake, by milk and milk constituents, 648*
Oxytocin,
effect of hourly milking with aid of, 1261
effect on milk and fat production during a lactation, 195
milk and butterfat production when udder evacuation induced by, 299

PARTURIENT PARESIS,
effect of calcium borogluconate on blood and urinary calcium in cows with, 661*
leucocytes of cows with, 967
levels of blood constituents in cows with, 185
Parturition,
blood protein changes associated with, 662*
conception rates from services at intervals after, 1042
constituents of blood at time of, 546
effect of management on response of cows following, 673*
prenatal mortality between pregnancy diagnosis and, 1071
Pasteurization, HTST, of ice cream mix, bacteriological studies on, 37
Pasture,
forages, ensiled with dried citrus pulp, 658*
grass, influence on milk production, TDN yield, and dry matter intake of cows, 665*, 666*
grazing behavior of lactating cows on, 665*
pangola-white clover, for cattle, 666*
practical methods for evaluation of, 676*
Penicillin, action on *V. fetus* in extended semen, 407, 416
Penicillium roqueforti, white mutants, for cheese making, use of, 711
Pens, for calves, outdoor portable vs. conventional housing, 562
People and Events, in dairy science, 107, 235, 336, 463, 676, 772, 900, 1014, 1134, 1247, 1383, 1476
Peptidases, endocellular, of *S. lactis*, 795

Peptides, in milk, formed by action of *S. lactis*, 790
Permeability, of the gut of the newborn herbivore, 653*
Peroxide test, for lipid oxidation in dairy products, 202
Phages, streptococcal, growth characteristics, in relation to cheese manufacture, 209
Phosphatase, alkaline,
effect of estrogen and progesterone on uterine distribution of, 671*
in bull blood, 30
Phosphatase test, factors affecting sensitivity and accuracy of, 698
Phosphate esters, in mammary gland extracts, biological activity of, 1027
Phosphates, irradiated, availability of phosphorus from, 661*
Phosphokinase activity, of the mammary gland, 505
Phosphorus,
dietary, incidence of milk fever as affected by, 360
from irradiated phosphates, availability of, 661*
requirements of bulls, rations for study of, 653*
Pipeline milking, and bulk milk handling, 583, 1486
Pituitary, histology of, in relation to production, 1074
Plant pigments, as indicator of digestibility, method for use of, 672*
Plasma calcium, and inorganic phosphorus, in bull blood, 30
Plasma vitamin A, as related to liver vitamin A in calves, 1376
Polenske method, for detecting substitute fats in ice cream, reliability of, 647*
Polysaccharide synthesis, by rumen bacteria, 662*
Potassium iodide, dietary, effect on protein bound iodine, 660*
Pregnancy, prenatal mortality between parturition and diagnosis of, 1071
Pregnancy test, Richardson biochemical, applied to cattle, 662*
Pregnanediol, assay of cows' urine for, 355
Preservative,
for frozen condensed skimmilk, 648*
for legume silage, 52
Production,
and feeding analysis, for New York DHIA herds, 675*
in DHIA herds, source of nutrients and their effect on, 675*
level, in cattle, genetic variation and covariation in, 668*
records,
of Kansas 4-H club members, 676*
when pipeline milkers are used, weighing and sampling for, 675*
testing programs, national survey of, 675*
Productive life, type score as related to, 666*
Productivity, of cattle, causes of differences in, 670*
Progesterone, effect on distribution of alkaline phosphatase and glycogen in the uterus, 671*
Propionibacteria, factors affecting acid production by, 638
Protamone (iodinated casein), using identical twin cows to determine effects of, 659*
Protein,
grain, for milk production, 671*
of silage corn, as influenced by fertilization, 976
stability, in frozen concentrated milk, effect of lactose crystallization on, 830
Proteins,
blood, associated with parturition, changes in, 662*
milk,
effect of heat and salts on sedimentation rates of, 633*
sedimentation of, 634*
serum, heat denaturation of, 633*
thyroactive iodinated, thyroxine content of, 1227
Psychrophilic bacteria,
destruction rate in skimmilk, 317
factors affecting growth of, 636*
growth in skimmilk as affected by temperatures, 1164
Public relations objectives, of the ADSA, proposed, 769

RAT,
effect of epinephrine on lactation in, 670*
stimulation of growth and function of mammary gland of, 669*
Rations,
cottonseed meal vs. urea vs. ammoniated molasses in, 657*
dicyanodiamide in, 657*
molasses and urea in, 284
vitamin A depletion, effect on blood constituents of calves, 857
Records, herd management, studies of, 162
Reichert-Meissl,
method for detecting substitute fats in ice cream, reliability of, 647*
numbers, of Kansas butterfat, 646*
Relaxin, effect on milk ejection in sheep, 1173
Rennet coagulation time, influence of bulk handling of raw milk on, 637*
Reproduction,
histology of the pituitary, testis, and adrenal in relation to, 1074
of bulls, effect of dehydrated grass on, 1123
rates, of Brown Swiss cattle in Brazil, 1145
Resin mixtures, effect on salt content of raw skimmilk, 571
Resources, role of dairy industry in utilization of, 472
Responses, metabolic, of spermatozoa to antibacterial agents, 228
Review:
Lipase, 775
Manufacture and use of lactose, 1106
Riboflavin,
and sunlight flavor formation in milk, 446
in rumen, influence of ration on synthesis of, 512
Richardson biochemical pregnancy test, as applied to cattle, 662*
Rickets, methods for detection of, 1220
Rodent control, in dairy processing plants, 348
Roughage,
effect on carotenoid and vitamin A content of milk, 311
influence on biochemical properties of milk, 1
susceptibility of milk to oxidized flavors as influenced by, 641*
Rumen,
cellulolytic bacteria of, 1176
miniature artificial, fiber digestion in, 328
of cows with ketosis, volatile fatty acids in, 664*

Rumen bacteria,
aspartate dissimilation reactions of, 531
effect of aureomycin and terramycin on, 1466
effect on potency of aureomycin and terramycin, 663*
formation of methane by, 662*
nutritional requirements of, 81
polysaccharide synthesis and lactic acid production by, 662*
unidentified factor required by, 663*
Rumen juice, of calves, influence of ration on volatile fatty acids in, 664*
Rumen microorganisms,
effect of aureomycin on in vitro cellulose digestion by, 663*
release of ammonia nitrogen by, 1449
Rumen synthesis, of vitamins, influence of ration on, 512

SAFFLOWER meal, undecorticated, for milk production, 671*
Salt content, of raw skimmilk, effect of resin mixtures on, 571
Salts, calcium, activity in casein sols, 634*
Sanitation, milk,
laboratory training program in, 1484
survey of, 1399
Sedimentation, of milk proteins, 633*, 634
Selection index, for fat production in cattle, 744
Self-help program, of National Milk Producers Federation, 628
Semen,
antibacterial agents for, 649*
diluters,
action of antibiotics against *V. fetus* added to, 407, 416
frozen skimmilk as, 650*, 1308
heated milk and egg yolk–citrate as, 1308
fertility level and treatment, influence on nonreturn decline, 938, 949
laboratory tests for evaluating fertility of, 1050
production,
of bulls ejaculated at various intervals, 1439, 1444
of bulls exposed to extreme climatic conditions, 667*
storage, maintenance of osmotic conditions during, 684
Service, intervals, repeat, influence of treatment and fertility level of semen on distribution of, 949
Sex ratio, and calving rates in artificial breeding, 673*
Sheep, effect of relaxin on milk ejection of, 1173
Silage,
corn,
effect on lactating cows of replacing hay with, 657*
nutritive value for milking cows, 957
yield and protein of, as influenced by fertilization, 976
effect of ensiling process on onion and ragweed flavors in, 58
evaluation, ear and leaf-stalk of corn forage as factor in, 1088
grass,
composition of, 1273
sodium meta-bisulfite as preservative for, 659*
Vermont, composition and nutrient value of, 658*
hay crop, use of acidifying salts in, 659*
legume,
milk production as affected by maturity of, 247
stacked, effect of ground corn on, 658*
sulfur dioxide as preservative of, 52
lima bean, for cattle, 658*
sweet potato vine, studies of, 1325
Sindhi-Jersey females, body weights and measurements of, 1420
Sires, in artificial service, appraising transmitting ability of, 245
Skimmilk,
buffer capacities of, 641*
fortification of, 624, 637*
frozen, use as semen diluter, 650*
frozen condensed, use of sucrose in preservation of, 648*
frozen condensed and dried, comparison of baking quality of, 649*
lipolytic enzymes of, 644*
psychrophilic organisms in, 317, 1164
salt content of, 571
unheated, effect of cysteine-HCl on spermatozoa in, 650*
Slime,
on blue cheese, microflora of, 436
on cottage cheese, formation of, 176
Sodium carbonate, activation of spermatozoa by use of, 651*
Sodium meta-bisulfite, grass silage made with, 659*
Soybean,
feeding, effect on plasma carotene and vitamin A in calves, 1269
flour, in milk replacement formulas, 373, 655*
oil meal, ammonia nitrogen released by rumen microorganisms from, 1449
Spectrographic analysis, of trace elements in whole milk, 643*
Spermatozoa,
activation by sodium carbonate, 651*
frozen,
factors affecting recovery of, 651*, 652*
factors affecting survival of, 45
fertility results with, 651*
relationship of diluter composition and glycerol equilibration time to survival of, 651*
in heated milks, fertility of, 1303
in milk, techniques for freezing, 652*
in raw skimmilk, effect of Cysteine-HCl on livability of, 650*
inseminated, fertility related to number of, 1353
interference by glycerol with differential staining of, 652*, 1094
livability of,
effect of lactenin and lactoperoxidase on, 1205
effect of milk proteins on, 220
longevity in pasteurized milk, 650*
metabolic responses to antibacterial agents, 228
stored at sub-zero temperatures, 650*, 1429
uptake of glucose-C^{14} by, 425
Spray drier, use of Venturi atomizer in design of, 647*
Staining, differential, of spermatozoa, glycerol interference in, 1094
Stanchion barn, labor requirements for pipeline operations in, 583
Starters, lactic,
free amino compounds in, 645*
lyophilized, use of, in cottage cheese and cultured milk, 637*
preservation of, by lyophilization, 639*
Streptococcus agalactiae, changes in casein induced by, 633*

Streptococcus (lactic) bacteriophage,
action of aerosol viricides on, 840
in liquids, action of viricides on, 847
Streptococcus cremoris,
acetate-citrate metabolism of, 635*
in cultured buttermilk, changes in numbers of, 1128
Streptococcus lactis,
acetate–citrate metabolism of, 635*
amino acids and peptides formed in milk by, 790
characteristics of endocellular peptidases of, 795
Streptococcus lactis var. *maltigenes*, identity of malty substance from cultures of, 1316
Streptomycin, action on *V. fetus* in extended semen, 407, 416
Student (collegiate), dairy products judging, evaluation of, 1021
Sucrose, as preservative for frozen condensed skimmilk, 648*
Sulfanilamide, action on *V. fetus* in extended semen, 407, 416
Sulfur: nitrogen ratios, in feed for cows, 813
Sulfur dioxide, as preservative for high moisture legume silage, 52
Sunlight flavor, in milk, mechanism of formation of, 446
Surface-active agents, in vivo and in vitro studies with, 737
Surpluses, dairy, problem of, 113
Sweet potato vine silage, studies of, 1325
Swiss cheese bacteria, factors affecting survival and growth of, 638*

TDN yield, of grass pastures, 665*
Teaching, dairy science, use of demonstrations in, 345
Teat cup, inflations of, 640*
Technologists, dairy, training of, 1397
Television, in extension programs, use of, 674*
Temperature, storage, effect on psychrophiles in skimmilk, 1164
Temperatures, sub-zero, spermatozoa stored at, 45, 650*
Terramycin,
effect of, on rumen bacteria, 1466
effect of rumen bacteria on potency of, 663*
effect on growth of calves, 654*
Testing programs, production, national survey of, 675*
Testis,
histology of, 669*, 1074
role of, in mammary gland duct growth, 674*
Thermal death time, of *B. abortus* in milk, 636*, 1291
Thiamine, in the rumen, influence of ration on synthesis of, 512
Thiobarbituric acid reaction, in oxidized milk fat, compounds responsible for, 647*
Thyroactive feed, milk production and body weight as affected by withdrawal of, 1212
Thyroprotein feeding,
effects of, 877
to identical twins, results of, 660*
Thyroxine, content of thyroactive proteins, 1227
Tin, in milk, quantitative spectrographic determination of, 1401
Tocopherol, effects on calves, 655*
Trace elements, in milk, spectrographic analysis of, 643*
Tracer studies, of milk secretion, specific activity-time relationship in, 670*
Twins, identical,
fed iodinated casein, 659*
fed thyroprotein, 660*
Type score, related to productive life, fat production, and age at first calving, 666*

ULNAR epiphyseal cartilage, width in normal and rachitic calves, 1220
Ultrasonic waves,
acceleration of cheese ripening by, 638*
homogenization and deaeration of milk by, 645*
Urea,
ammonia nitrogen released by rumen microorganisms from, 1449
and molasses, in rations of growing cattle, 284
vs. cottonseed meal vs. ammoniated molasses in ration, 657*
Urine, cows', assay for pregnanediol in, 355
Uterus, distribution of alkaline phosphatase and glycogen in, 671*

VACUUM level, effects on production, milking time and rate, 276
Veal production, butyrated lard in "filled milk" for, 431
Venturi atomizer, in spray drier design, 647*
Vibrio fetus, in extended semen, action of antibiotics on, 407, 416
Viricidal agents,
action on lactic streptococcus bacteriophage in liquids, 847
aerosol action on bacteriophage, 840
Visuals, new developments in, 675*
Vitamin A,
and carotenoid content of milk, 147
and carotenoids in calf liver, estimation of, 1474
content of milk, effect of form of alfalfa on, 311
depletion ration, effect of intake on blood constituents of calves, 857
hay-like flavor in low-fat milk fortified with, 1346
in plasma of calves, 1269, 1376
vs. carotene, for calf feeding, 889
Vitamin B, levels of, in blood of calves, 1190
Vitamin B_{12}, effect of, on production, composition, and vitamin B_{12} of milk, 677
Vitamin D, in forages, factors affecting, 1337
Vulvo-vaginal mucosa, agglutination test in study of microflora of, 671*

WASHINGTON, milk production, management practices and net returns in, 14
Wettability method, for powdered milk, 863
Wheat concentrate, processed, isolation and identification of causative agent of hyperkeratosis from, 662*
Whey,
protein-free, electrolytic deionization of, 932
solubles, in milk replacement formulas, 373, 655*
Wind, effect on cows, 674*
Wisconsin Cheese Exchange, 909

XANTHINE oxidase, in dairy products, 644*

AUTHOR INDEX OF ABSTRACTS

ACKERSON, C. W., Chick-growth stimulation by alfalfa juice, A39

ADACHI, S., antioxygenic action of vitamin C, A6

ADAMS, D. H., effects of milk diet deficient in metals, A127

ADAMS, H. S., standards for cream quality, A76; standards for cream used in ice cream, A107

ADAMS, M. F., mineral metabolism in cows at parturition, A1

AITKEN, J. N., effects of feeding iodinated casein and L-thyroxine to cattle, A34

AIYER, R. A. K. Y. N., principles of crop husbandry in India, A79

ALBRECHT, T. W., watered milk, A108

ALDERTON, G., antibiotic feed supplements, A14

ALEXANDER, B. H., sequestration by sugar acids, A53

ALEXANDER, H., bacteriological studies on pasteurized milk, A7

ALFIN-SLATER, R., harmlessness of sorbic acid, A57

ALIM, K. A., effect of system of management of dairy cattle on milk yield, A35

ALLEN, C. H., test organisms to determine sanitary quality of food, A133

ALLEN, O. E., Missouri taps school market, A121

ALLRED, W. M., costs and quality of fluid milk, A85

American Soc. Refrigeration Eng., proposed safety code revision, A10; Refrigerating Data Book, eighth edition, A41

AMERINE, M. A., errors in organoleptic difference testing, A80

ANDERS, R. S., baits for control of resistant flies, A155

ANDERSEN, K. P., testing antioxidants for butter, A91; treating dairy waste water in septic tanks, A128

ANDERSON, A. E., animal drinking bowl, A35; valved coupling for milking system, A36

ANDERSON, D., study of fertility in twin cattle, A35

ANDERSON, I., changes in diacetyl and plate count of stored butter, A143

ANDERSON, R. F., multiflavor ice cream nozzle, A87

ANDRAL, L., *Galega officinalis*, poisonous plant, A26

ANISFELD, L., metabolism of sorbic acid, A57

ANISIMOVA, V., iodine content of milk, A10

ANNETT, F. A., pumps, A41

ANON., calves thrive in portable pens, A2; pumping curd saves labor, A4; ripening in Cheddar cheese, A4; influence of kind of pasture on milk production, A15; super market survey on ice cream, A19; World Congress for milk utilization, A21; factors affecting physico-chemical properties of milk, A21; selling nutritional value of dairy products, A23; students in cooperative milk plant, A32; milk sales with bulk flow dispensers, A32; light truck refrigeration system, A45; one will do, A46; future supplies of paper milk containers, A47; Borden's newest ice cream plant, A50; ice cream in foreign lands, A50; more fountains in supers, A50; volume up on vegetable fat frozen dessert, A50; use of hydraulic jet cleaners, A53; milk customers: R.F.D., A58; electric arc welding of piping, A58; automatic dairies, A58; ice cream industry trends, A60; individuality in ice cream stencils, A61; milking methods and milk fever, A65; new market for concentrated milk, A67; factors influencing cheese grade, A67; company credit unions, A71; whole cottonseed in dairy rations, A73; milk as semen diluter, A73; winter feeding systems, A73; machine-made milkshakes, A75; modern wash facilities, A77; testing whey solids, A81; nonfat dry milk sales, A81; DISI's world congress for milk utilization, A85; farm record summary, A87; outer-market sales, A94; sub-zero holding room on wheels, A94; tips for retailers, A94; vending milk builds sales, A95; super market survey on fluid milk and milk products, A103; state regulations for cream used in ice cream, A108; pitfalls and profit, A120; what people think of your products, A122; problems in bulk pick-up, A122; analysis of 1953 packages by container sizes, A125; switch to self-service stores, A125; plastic containers for dairy products, A136; butter cartons, A136; manufacturing costs of butter, A136; cheese yield from Red Danish and Jersey milk, A144; marketing cheese curd, A145; developing tests for foreign fats, A148; dairy plant labor, A149; who buys dairy products—and why?, A150; 1953 ice cream sales, A153; analysis of 1953 mellorine volume, A153

ANTELA, M., effect of oxidizing salts on Emmentaler cheese, A144

ANTHONY, W. B., serum alkaline phosphatase activity in cattle, A24

ANTILA, M., stability of vitamin A and carotene in butter, A154

APPLEBY, J. C., viable counts of rumen facultative anaerobes, A6

ARAKAWA, T., pyruvic acid and acetaldehyde in human milk, A31

ARBUCKLE, W. S., special products research, A59; vanilla-like synthetic flavor, A60

ARKIN, C., manufacture of cheese, A4

ARMSTRONG, T. V., solvent extraction method for estimation of WIA in cream, A88

ARNOLD, C. J., conventional lines cleaned-in-place, A53

ARNOLD, P. T. D., millet pasture for cattle, A14; development and survival of calves, A17; butterfat tests affected by roughage, A33; dairy calves, A74; minerals for cattle, A123; dairy calves, A124; productive life-span of dairy cattle, A124

ARTOM, A., vitamin B_2 content of cheese, A43

ASCHAFFENBURG, R., nutritive value of colostrum, A25; reviews of progress in dairy science, chemistry, A68

ASKONAS, B. A., biosynthesis of milk proteins in goat, A39

ATKESON, F. W., streaked hairlessness in Holsteins, A59

AUCLAIR, J. E., antibacterial substances of milk, A127; separation of bacteria inhibiting fractions of raw milk, A145

BABAD, G., specific gravity of reconstituted skimmilk, A133

BABCOCK, C. J., analysis of flavor research on milk, A97

BABICH, N., experimental work on continuous buttermaking process, A4

BABSON, H. B., filling milk containers, A84

BACKER, J., multiple sclerosis in Norway, A39

BAGDANOV, V. M., intensification of aroma of butter cultures, A3

BAILEY, G. F., xanthophylls in alfalfa, A93
BAILEY, G. L., feeding value of cattle foods, A72; influence of live weight on milk production, A73; rate of milk secretion, A89
BAKER, F. H., placental transfer of vitamin A and carotene by cows, A39
BAKER, G. A., errors in organoleptic difference testing, A80
BAKER, M. P., effect of time and temperature on bacterial counts of milk, A82
BALBOUS, H., pressed vs. extracted linseed cakes as feed, A49
BALCH, C. C., effect of water intake on digestibility of hay, A16; effect of concentrate protein on fat content of milk, A137; effect of variations in hay on fat content of milk, A137
BALCH, D. A., effect of water intake on digestibility of hay, A16; effect of concentrate protein on fat content of milk, A137; effect of variations in hay on fat content of milk, A137
BALDANZA, N. T., mold for home frozen confection, A124
BALDAUSKI, F. A., high protein milk product, A116
BARBER, F. W., no-hold pasteurization, A21; new plate count medium for milk, A100
BARER, R., refractive index of concentrated protein solutions, A102
BARNES, R. H., osmotic pressure of semen diluents, A86
BARNICOAT, C. R., fishiness in butter, A132
BARNSKY, G., hard butter composition, A42
BARRY, J. M., ionic and lactose concentrations of milk, A10; A127; mammary synthesis of lactose from glucose, A128; mammary synthesis of casein from glutamine, A154
BARTLETT, R. W., selling more at lower costs, A45; trends in dairy industry, A47
BARTLETT, S., nutritive value of colostrum, A25; effect of concentrate protein on fat content of milk, A137; effect of variations in hay on fat content of milk, A137
BASU, K. P., determination of milk solids, A83
BATTAGLIA, B., preparation of sperm heads for X-ray diffraction, A25
BATTAGLINI, A., nutritive value of carob, A49
BAUM, E. L., cost of analysis of milk handling on farms, A17
BAUMER, E. F., formulas for pricing milk, A38; shifts in milk and cream production, A136
BEALL, G., liver stores of carotenoids and vitamin A in calves, A23; effects of once-daily milking, A138; vitamin A depletion time in calves, A52
BEAVENS, E. A., frozen citrus concentrates, A60
BECK, K. M., use of sucaryl in frozen desserts, A61
BECK, P., trends in ice cream costs, A37
BECKER, R. B., development and survival of calves, A17; butterfat tests affected by roughage, A33; dairy calves, A74; A124; minerals for cattle, A123; productive life-span of dairy cattle, A124
BECKERLEG, D., continuous vitamin fortification of milk, A127
BEDFORD, J., employee grievances, A151
BEDWELL, J. W., floating ice cream parlor, A152
BEER, D. A. E., apparatus for ice cream sandwich, A87
BEHLING, C. R., machine for frozen confections, A87
BELL, M. C., urea nitrogen in rations containing carbohydrate feeds, A13
BELOUSOV, A., surface phenomena in butter-formation, A42
BENDER, M., amino acid composition of γ-casein, A31
BENK, E., milk emulsions containing Osmaron B, A101
BENNETT, B. H., manufactured dairy products, A13
BENSON, E. T., turning problems into opportunities, A11
BENTLEY, G. D., calf table, A86
BERCH, S. H., ice cream packaging machine, A103
BEREZOVSKAYA, A., enrichment of sour milk products, A23
BERGMAN, E. N., biochemical and toxic effects of salts on calves, A24
BERRIDGE, N. J., method for preparing crystalline rennin, A118; preparing crystalline rennin, A135; separation of bacteria inhibiting fractions of raw milk, A145
BERT, M. H., determination of metabolic fecal nitrogen, A110
BEST, A. M., livestock feeder, A36
BEVINGTON, K. A., bagging machine, A20
BHAT, J. V., saffron and nutmeg in milk preparations, A82
BICKOFF, E. M., xanthophylls in alfalfa, A93
BIGELOW, W., JR., factors for efficient dry ice refrigeration, A11
BIGGS, D. A., detecting substitute fats, A44
BIGWOOD, E. J., amino acid composition of papain, A118
BINDER, R., cottage cheese with raisins, A42
BINGER, H. P., hemicelluloses from orchard grass, A102
BISHOV, S. J., effect of calcium removal on properties of milk, A135
BIXBY, J. N., factors affecting nutritive value of milk, A154
BLACK, A. L., propionate as precursor of milk constituents, A26
BLACK, H., ice cream profits, A95
BLACK, W. G., bactericidal activity of the uterus, A106
BLACKBURN, P. S., cells in bovine milk, A65
BLACKSHAW, A. W., effects of salts on motility of spermatozoa, A26
BLAIR, S., reviews of progress in dairy science, physics, A68
BLANTON, L. F., cold milk separation, A126
BLENDEN, H. D., metabolism of sorbic acid, A57
BLOCK, R. J., milk protein food product, A30
BLOSSER, T. H., mineral metabolism in cows at parturition, A1; variation of estimates of forage digestibility, A105
BLOXHAM, R. H., block ice cream slicer, A19; ice cream stick dispensing machine, A20
BLUM, A. E., microbial method of determining protein value, A105
BOARD, F. S., apparatus for treating liquids, A45
BOBECK, F., changes in diacetyl and plate count of stored butters, A143
BOCCHINO, J. J., washing machine for cases, cans, and crates, A128
BOILEAU, A. H., apparatus for treating liquids, A45
BOITSUN, V., influence of dispersion of dried milk on stability, A6
BOLLIGER, A., composition of kangaroo milk, A31
BOND, V. V., method for ice cream sundaes, A153
BONEWITZ, E. L., spray cleaning evaporators and vacuum pans, A112

BORCHERS, R. L., chick-growth stimulation by alfalfa juice, A39
BORCK, A. G., device for homogenizing liquids, A84
BORMUTH, W. D., manufactured dairy products, A13
BORNOR, D. H., high protein milk product, A116
BOSCH, A. J., factors affecting nutritive value of milk, A154
BOTHAM, G. H., corrosion of aluminum dairy equipment, A18
BOUCKAERT, J. H., uptake of plasma amino acids by cow udder, A26
BOULET, M., titration curves of whey constituents, A135
BOURNE, G. H., biochemistry and physiology of nutrition, A2; biochemistry and physiology of nutrition, Vol. II, A91
BOWER, K. W., effect of tannins in feeds on milk production, A137
BOWRING, J. R., tank-truck assembly of milk, A150
BOYER, L. L., cooler door, A136
BOYLE, J. R., milk cooler, A18
BOYNE, A. W., effects of feeding iodinated casein and L-thyroxine to cattle, A34
BRABSON, J. A., flame photometric determination of calcium in phosphoric acid, A102
BRANDOW, G. E., changes in milk production, A21
BRAUDE, R., sow milk for rats, A23
BREITHAUPT, D. E., cattle insecticide applicator, A53
BRENCIS, K., needles of coniferous trees as food for domestic animals, A34
BRERETON, J. G., high protein milk product, A116
BREWER, C. R., nutrition of *B. melitensis*, A31
BREWER, J. A., milking machine timer, A151
BRIGGS, C. A. E., serological typing of group N streptococci, A7
BRIGGS, M., classification of lactobacilli by physiological tests, A6
BRINDLEY, M., surface microflora of Stilton cheese, A146
BRINEGAR, G. K., market for fluid skimmilk, A85
BRODY, S., environmental physiology, A24; A141; acid-base balance of cattle, A111
BROERSMA, S., measuring temperature in steel cap pasteurizer, A89
BROKER, R., saffron and nutmeg in milk preparations, A82
BROOKE, M. S., differentiation of *A. aerogenes* and *A. cloacae*, A31
BROSTER, W. H., feeding value of cattle foods, A72; influence of live weight on milk production, A73
BROWN, A. G., ice cream scoop, A51
BROWN, B. B., feeding value of cattle foods, A72
BROWN, L. J., alkaline cleaners for HTST pasteurizers, A128
BROWN, M. A., propionate as precursor of milk constituents, A26
BROWN, R. W., increasing homogenizer capacity, A51; viscosity of cream, A51; determining reconstituted milk in milk colorimetrically, A117
BRUNNER, J. R., amino acid composition of fat-membrane proteins, A9; electrophoretic patterns of fat-membrane proteins, A9; sedimentation diagrams of fat-membrane proteins, A9
BRYANT, L. R., detection of substitute fats, A44
BRYSON, W. R., corrosion of aluminum dairy equipment, A18
BUNDESEN, H. N., detection of vegetable gums in dairy products, A83
BUNYAN, J., fatal hypocalcaemia-like syndrome in cows, A79
BURKEY, L. C., dual operation of HTST pasteurizer, A96
BURNIGHT, R. G., hired workers on dairy farms, A18
BURROUGHS, W., factor stimulatory to cellulose digestion in lambs, A13
BURTON, H., color changes in heated and unheated milk, A134
BUTZ, W. T., distributor knowledge of state milk control in Pa., A11; producer knowledge of state milk control in Pa., A12; consumer knowledge of state milk control in Pa., A12
BUYSSE, F., new chemicals in preparing silages, A49
BUZAS, A. F., valve-actuating mechanism, A148

CABLE, J. B., induction and dielectric heating, A115
CADROBBI, B., new index for butter analysis, A42
CALBERT, C. E., metabolism of sorbic acid, A57
CALBERT, H. E., influence of agitation on Babcock test of bulk milk samples, A76; sediment testing of bulk milk, A88
CALLING, J., refrigeration control, A84
CAMA, J. S., component acids of whole milkfat, A118
CAMERON, M. P., mammalian germ cells, A56
CAMPBELL, P. N., biosynthesis of milk proteins in goat, A39; amino acid uptake by mammary gland, A77; source of antibody in milk, A127
CAMPBELL, R. C., semen diluents, A85
CANNON, P. R., dietary protein heat injury, A23
CANNON, R. Y., milk quality as affected by handling methods, A107
CAPPER, O. C., comments on starter butter, A92
CARNCROSS, J. W., production and price trends, A149
CAROL, J., chromatographic separation of progesterone and testosterone, A119
CARPENTER, S. E., dairy labor requirements, A74
CARROL, E. G., microbial fermentation in bovine rumen, A136
CARTER, P. J., coating composition for frozen confections, A87
CASON, J. L., pH of the bovine rumen, A111
CASS, R. S., determining densities of viscous fluids with Babcock bottles, A31
CERUTTI, G., effect of rapid freezing of milk on stability of casein, A10; characteristics of Argentine butter, A42
CHANDA, R., partition of milk carotenoids and vitamin A throughout lactation, A69; effect of mastitis on carotenoids, vitamin A, and phosphorus in milk, A113
CHAPMAN, R. A., detection of adulteration of butter, A134
CHAPPEL, C. F., digestibility of prairie hay, A105
CHÂRIET-LÉRY, G., analyses of animal feeds, A16
CHERBULIEZ, E., identity of γ-casein from casein or paracasein, A31
CHERREY, G., protein reducing value of milk as indication of nonfat dry milk solids, A9
CHIVERS, W. H., bloat treated with antibiotics, A79
CHOI, R. P., protein reducing value of milk as indication of nonfat dry milk solids, A9
CHUNG, A. C., effect of glucose injections on milk production, A110
CHYTIL, F. S., filling apparatus, A75

CLARKE, D. A., JR., pricing fat and skim components of milk, A71
CLARKE, H. W., food brokers, A12
CLAUDE, P., detection of antibiotics in milk, A22
CLAYDON, T. J., double stage sediment tester, A109; rates of deterioration of inoculated milk, A134
CLEARY, R. E., the subdealer, A123
CLEMENS, W., paper chromatography of amino acids in cheese, A100
CLEVELAND, W. F., automatic stock waterer, A36
CLICKNER, F. H., food product, A116
CLOSE, J., amino acid composition of papain, A118
CLOUGH, P. A., pulsation and milking rate, A38; rate of milk secretion, A89
COIN, L., putrescibility of dairy sewage, A28
COLEMAN, R. D., effect of calcium removal on properties of milk, A135
COLLINS, R. W., expand your laboratory services, A94
COLOVOS, N. F., coarse grain or fine, A73; limestone lowers silage digestibility, A151
COMAR, C. L., effect of phenothiazine on thyroid uptake of radioiodine, A111
COMBERG, G., nutritive value of tobacco seed extraction in cows, A34
Committee for standardization of methods (Neth.), determination of titratable acidity of milk, A83
COMPTON, C. C., insecticides in foods, A111
CONDE, L. T., milking machine pulsator, A87
CONIFF, F. E., accurate bacterial counts of milk films, A116
CONLEY, T. F., influence of lipids on dispersion of milk powder, A133
CONNER, M. C., specifications and costs for a milk plant, A47
CONNORS, W. M., nutritional assay of powdered whey, A93
COOK, D. J., supermarket merchandising, A46
COOK, H. L., vending machines an opportunity for new milk plants, A121
COOLEY, J. M., manufactured dairy products, A13
COON, H. R., SR., butter print mold, A143
COOPER, J. H., deterioration of milking rubbers, A35
COPPENS, R., biochemistry of starter flavor formation, A119
COPPING, A. M., purified casein, A140
CORNELISSEN, H., antibiotic action of polyunsaturated fatty acids in milk, A125
COTTE, A., sorghum fodder, A16
COTTELL, E. C., apparatus for production of vibrations for emulsification, A11
COUGHLIN, L. J., pre-dipping bulk for greater sales, A108; pre-dipping bulk ice cream, A125
COUP, M. R., investigating faeces of grazing cows, A49
COURTNEY, J. L., tabulation of plate counts on frozen desserts, A37; coliform and standard plate counts, A43
COX, C. P., effect of concentrate protein on fat content of milk, A137
CREMERS, L. F. M., special products research, A59; vanilla-like synthetic flavor, A60
CRICHTON, J. A., effects of feeding iodinated casein and L-thyroxine to cattle, A34
CRIPPEN, C. C., milk can container, A5
CRUESS, W. V., cottage cheese with raisins, A42
CUNNINGHAM, I. J., relation of copper and molybdenum to diseases of cattle and sheep, A2
CURCIO, M., food delivery box, A48
CURRIE, C., effect of dietary supplement on skeletal maturation of children, A23

DAANEN, S. J., forming head for ice cream tarts, A20
DACRE, J. C., relation of tyramine production to Cheddar cheese flavor, A4
DAGLEY, S., enzymatic estimation of citric acid, A118
DAHLE, C. D., making a dry product, A59; low carbohydrate ice cream, A74; A87
DALE, H. E., acid-base balance of cattle, A111
DALMEIREN, S., nutritional value of beet molasses, A49
DAM, H., influence of tocopherol on milk yield and milk fat, A33
DAMMERS, J., trials with low and high fat rations, A123
DANILOFF, K. B., stabilized lactic casein solution, A5
DAS, B. K., *Themeda quadrivalvis* as cattle feed, A16; Joy-Joha grass as cattle feed, A34
DAUME, H. E., copper and Cheddar flavor, A43
DAVE, C. N., variations in milk from different quarters of udder, A89
DAVIDOV, R., iodine content of milk, A10
DAVIS, A. V., antibiotic studies with calves, A73
DAVIS, C. O., JR., sell dairy chocolate to restaurants, A33; selling farmers dairy products, A72; modern case-handling, A94; volume and profit in outdoor vending, A120; vending hits big time, A121; tank conversion route-by-route, A122
DAVIS, G. K., minerals for cattle, A123
DAVIS, H. A., limestone lowers silage digestibility, A151
DAVIS, R., high heat treatment of milk, A76
DAWES, E. A., enzymatic estimation of citric acid, A118
DE, S. S., processing and nutritive value of vegetable milk, A43
DEBAUN, R. M., nutritional assay of powdered whey, A93; new plate count medium for milk, A100
DEBEER, G., improvement of milk quality by ultracentrifugation, A8
DECKER, H. M., ultraviolet irradiation in air conditioner, A101
DE FRANCESCO, F., detection of fish fats in butter, A42; new index for butter analysis, A42
DEMBICZAK, C. M., liver stores of carotenoids and vitamin A in calves, A23
DEMOTT, B. J., testing half and half homogenized milks, A70
DEMUROV, M., manufacturing dietetic sour dairy products, A52
DEN HERDER, P. C., detecting adulteration of butter by margarine, A42
DE PEW, H. F., ice cream production problems, A95; A96
DESIRANT, J. M., detection of margarine in butter, A42
DEUEL, H. J., JR., harmlessness of sorbic acid, A57; metabolism of sorbic acid, A57
DICKE, R. J., maggot therapy of actinomycosis, A1; production of hyperkeratosis in calves, A55; chemical control of cheese mites, A66
DICKSON, J. H., laboratory instruments, A98
DIMOV, N., procedure for determining butterfat in milk, A103
DITTMER, K., effect of menadione on milk souring, A52; A108
DLYACHENKO, P. F., method for obtaining edible milk albumin, A6

DODD, F. H., pulsation and milking rate, A38; variations in rate of machine milking, A38; relationship between mastitis and stripping method, A65; rate of milk secretion, A89
DOERING, H. H., feed roller attachment for butter print machinery, A148
DOLBY, R. M., photoelectric determination of fat aldehyde values, A9; effect of treatments on size of fat globules in cream, A20; churn for cream samples, A131; effect of temperature of cream before churning on butter, A132
DOLGE, K. L., carotenoid loss in farm stored, dried alfalfa, A15; effect of aureomycin supplement on calf growth, A15
DOMINGO, E., milking machine, A87
DONALD, H. P., study of twin cattle, A34; study of fertility in twin cattle, A35
DONOVAN, H. P., tailor made dry milk solids, A67
DOTTER, M. J., dual operation of HTST pasteurizer, A96
DOWD, L. R., cold milk separation, A20
DRACY, A. E., progesterone and relaxin as aids in ova transfer, A90
DREIZEN, S., effect of dietary supplement on skeletal maturation of children, A23
DUCKWORTH, J., rations for livestock, A13
DUGAN, L. R., JR., animal fats in feed, A16
DUNCAN, C. W., amino acid composition of fat membrane proteins, A9; electrophoretic patterns of fat-membrane proteins, A9; sedimentation diagrams of fat membrane proteins, A9
DUNCOMBE, W. G., glucose and acetate oxidation by mammary tissue, A128
DUNMIRE, R. P., new processes and equipment, A148
DUSCHINSKY, R., colorimetric determination of ascorbic acid, A147
DYE, J. A., glycemic levels and rumen development, A39
DYKSTRA, N. D., trials with low and high fat rations, A123

EASTERBROOKS, H. L., effects of abnormal machine milking, A56
EATON, H. D., carotenoid loss in farm stored, dried alfalfa, A15; effect of aureomycin supplement on calf growth, A15; liver stores of carotenoids and vitamin A in calves, A23; vitamin A depletion time in calves, A52; effects of abnormal machine milking, A56; effects of once-daily milking, A138
EDMUNDS, R. S., JR., butter cutting machine, A103
EDWARDS, J., semen diluents, A85
EGG-LARSEN, N., physiology of calcium metabolism, A24
EGOROV, S., enrichment of sour-milk products, A23
EKWALL, N. R. G., plate type heat exchanger, A84
ELDRIDGE, F. E., streaked hairlessness in Holsteins, A59
ELLENBERGER, H. B., effects of feeding hay and cod-liver oil to dairy cattle, A14
ELLIKER, P. R., evaluation of sanitizing agents, A98; effect of hypochlorite on detergent activity of alkaline cleaners, A112
ELLIOTT, A., laboratory instruments, A98
ELLIOTT, F. I., effect of aureomycin supplement on calf growth, A15; effects of once-daily milking, A138
ELLIS, R. W. B., tests for adulteration of human milk, A10
EL-SOKKARY, A. M., non-fat-solids of cow and buffalo milk, A89
ELVEHJEM, C. A., factors affecting nutritive value of milk, A154
ELWELL, E. S., Elwell plan to date, A46
EMANUILOV, I., antibiotic properties of cheese, A100
EMILSON, E., production of bottled milk and cheese, A33
ENGLAND, C. W., good buttermilk, A67; dairy plant sanitation, A98; plant sanitation, A129
ENRIGHT, J. B., relation of Q-fever to dairy products, A1
ERB, J. H., engineering needs of dairy industry, A104
ERB, R. E., variations in fat percentage, A86; improving accuracy of lactation testing, A86
ERIKSSON, S., adding "Kofa" salt to ensilage, A16
ERLING, S. J., pneumatic pulsator, A36
ESKEDAL, H. W., concentrates for cows, A33
ESMOND, C. W., holding ice cream consumers, A37
EVENHUIS, N., manufacture of aromatic butter, A80; oxygen uptake in starters, A116; biochemistry of starter flavor formation, A119

FABIAN, F. W., test organisms to determine sanitary quality of food, A133
FABRICIUS, N. E., flavor in butter, A98
FARFALETTI-CASALI, P. L., characteristics of Argentine butter, A42
FEAR, E. D., cultured milk powder, A67
FENDER, V. L., dehorning tool, A18
FENZAU, C. J., quality milk at lower costs, A124
FERRANDO, R., animal protein factor, vitamin B_{12}, and antibiotics in feeding animals, A34
FERRIS, R. G., milk can rack, A124; milk can hoist, A124; milking parlor stall, A151
FILANDRO, A. S., detection of ethylvanillin extract, A118
FINNEGAN, E. J., conventional lines cleaned-in-place, A53
FISCHER, P., sympathomimetic activity of organ extracts, A26
FISKER, A. N., influence of tocopherol on milk yield and milk fat, A33; testing antioxidants for butter, A91; keeping quality of printed butter, A92
FITZGERALD, P. R., survival of *Trichomonas foetus* in semen, A55
FLEISCHHACKER, J., edible whips, A6
FLOUNDERS, C. L., sound financing for expansion, A71
FOGH, J., microdetermination of quaternary ammonium compounds, A68
FOHRMAN, M. H., heat tolerance of cows, A24; heat tolerance tests, A24; water evaporation from body surface, A110
FOLDS, T. R., cleaning glass lines in place, A40
FOLEY, G. E., synthesis of citrovorum factor by *L. citrovorum*, A31
FOLLEY, S. J., incorporation of acetate into lactose and glycerol by the udder, A110
FOOT, A. S., feeding value of cattle foods, A72
FORA, C. C., conventional lines cleaned-in-place, A53
FORSLEW, J. H., engineering the plant of the future, A149
FOX, K. A., analysis of demand for farm products, A17
FRAM, H., new plate count medium for milk, A100
FRANCE, R. L., comparison of numbers of coliform bacteria and enterococci in raw sewage, A27

FRANCIS, L. H., whey products and process of manufacture, A5
FRANCOIS, A., analyses of animal feeds, A16
FRANZ, H. H., mechanism for filling containers, A70; bottle filler valve, A103
FRAYER, J. M., coliform in ice cream, A96
FRAZIER, L. E., dietary protein heat injury, A23
FRAZIER, W. C., sanitation of farm milk pipelines, A63; bacteriological studies of farm milk handling, A82
FREDERICKSON, L. P., future of butter, A3
FREEMAN, J. S., mammalian germ cells, A56
FREIMUTH, U., fractionation of whey proteins, A44
FRENCH, T. H., biosynthesis of milk-fat from acetate and glucose, A109
FRENS, A. M., trials with low and high fat rations, A123
FRIEDMAN, M. E., influence of metabolites on p-aminobenzoate-pantothenate interaction in *B. linens*, A7
FRYE, J. R., pump and pipe processing, A139
FRYREAR, J. J., grade "A" milking parlor, A18; portable milking barn, A152
FUCHS, W., properties of continuously sterilized milk, A154
FULTON, R. A., effectiveness of lindane vaporizers, A27
FUTRELL, M. F., serum alkaline phosphatase activity in cattle, A24
FUTTER, H., all weather salt block, A15

GABRIELSEN, C., merchandising machine for frozen comestibles, A76
GAHAN, J. B., toxicity of vapors to house flies, A27; baits for control of resistant flies, A155
GAINER, H., colorimetric determination of ascorbic acid, A147
GALESLOOT, T. E., investigations on methylene blue reduction test, A88; detection of organic preservatives in milk, A147
GALLUP, W. D., urea nitrogen in rations containing carbohydrate feeds, A13; carotene and vitamin A metabolism in cattle, A23; metabolism stall for steers, A111
GARBER, R. J., diseases of forage grasses and legumes, A106
GARDNER, E. R., deterioration of milking rubbers, A35
GARIBALDI, J. A., antibiotic feed supplements, A14
GARIEPY, V., dilator for clogged teats, A29
GARLICK, N. L., clinical diagnosis of oxen teeth, A131
GAVER, M. J., device for reversing inflations, A74
GEBERT, M., sound dairy program, A12
GELPI, A. J., JR., limiting oxidation of frozen cream, A62
GEMMILL, A. V., new procedures in fresh-cheese making, A42; single product benefits—multi product plant, A93
GERAUER, H., estimation of copper in dried milk, A102
GERSDORFF, W. A., fly toxicity of methyl and ethyl analogs of allethrin, A155
GETTEN, L. L., the challenge to dairy farmer, A58
GIANNOTTI, D., effect of *Helichrysum italicum* extract on vitamin C content of sheep milk, A26
GIBSON, D. L., improving ease of reconstitution of skimmilk powder, A92
GILBERTY, P., automatic ice cream filler, A37
GILCREAS, F. W., pasteurization tests, A22
GIRVIN, M. D., reconstituted milk process, A22
GLASCOCK, R. F., incorporation of acetate into lactose and glycerol by the udder, A110; glucose and acetate oxidation by mammary tissue, A128
GLAZIER, L. R., cold milk separation, A20
GLOVER, T., radioactive sulfur and ergothioneine formation in pig, A39
GLUKHOF, G., fat test of milk, A10
GÖBELT, J., fat-albumin correlation, A31
GOBERDHAN, C. K., acid-base balance of cattle, A111
GOETCHIUS, G. R., testing quaternary ammonium germicides, A31
GOLDBLITH, S. A., radiation sterilization of foods, A101
GOODHUE, L. D., new fly repellents, A154
GOODING, C. M., metabolism of sorbic acid by molds, A57; resistance of sorbic acid to oxidation, A57
GOODMAN, J. E., apparatus for production of vibrations for emulsification, A11
GOODWIN, M. M., variations in fat percentage, A86; improving accuracy of lactation testing, A86
GOODWIN, W. J., fly repellent tests on cattle, A154
GORANSSON, B., chromatography of amino acids in cheese, A147; chromatography of volatile acids in cheese, A147
GORBACHEVA, A. P., methods of studying cow urine, A39
GORDON, W. G., amino acid composition of γ-casein, A31
GORRIE, C. K., influence of silage on milk flavor, A14
GOURD, C., Connecticut mastitis-control program, A1
GRAF, T. F., grass silage and Swiss cheese quality, A66
GRAHAM, G. W., effect of tannins in feeds on milk production, A137
GRAHAM, J. H., diseases of forage grasses and legumes, A106
GRAHAM, R. P., pectin production, A19
GREEN, D. W., branch accounting systems, A94
GREENWOOD, H. N., pitcher, A85
GREGORY, J. B., determining densities of viscous fluids with Babcock bottles, A31
GREGORY, V. L., composition for lithographic plate coating, A145
GRIBSKOV, L. K., milk bottle carrying device, A104; carrier for paper milk cartons, A104
GRIGNAC, P., sorghum fodder, A16
GRIMBLEBY, F. H., heat-induced acidity in milk, A134
GRIMM, H., milk sampling apparatus, A52
GRINDROD, G. E., cheese slice treatment, A133; cheese packaging, A133
GRINSFELDER, H., testing quaternary ammonium germicides, A31
GRINSTED, E., anaerobic spore-formers from cheese, A146
GROENWALD, J. W., Lucerne hay digestibility, A16
GROPEN, E. M., beater mechanism, A20
GROSS, A. M., quantitative paper chromatography of amino acids, A68; quantitative determination of amino acids, A82
GROSS, F. C., filling apparatus, A75
GRUMBLY, G. P., flavor injection unit, A51
GRUMMER, R. H., livestock production, A131
GRÜNPETER, A., determining fat in soft cheese, A43
GULATI, K. C., indicators for detection of hydrogenated oil, A10

GUNDLACH, G. P., holding ice cream consumers, A37
GUSTAFSON, C., action of aliphatic thiocyanates against fly, A27
GUYER, G., fly control in dairy barns, A40
GYLLENBERG, H., evaluating artificial human milk, A154

HABGOOD, W. J., apparatus for coating ice cream in cones, A153
HADDON, C. B., experiments with legumes, A105
HADLAND, G., serological detection of cow milk in goat milk, A126
HADLEY, F. B., principles of veterinary science, 5th ed., A66
HAFEZ, S., hormonal mechanism of mammary development, A26
HAHN, M. K., container for dispensing liquids, A81
HALE, H. H., Connecticut mastitis-control program, A1; effects of abnormal machine milking, A56
HALE, W. H., factor stimulatory to cellulose digestion in lambs, A13
HALEY, E. C., synthesis of citrovorum factor by *L. citrovorum*, A31
HALL, C. M., engineer's analyses of bulk milk handling, A51
HALL, C. W., paper vs. glass, A84
HALL, R. E., relationship of vitamin A to hyperkeratosis, A55
HALLS, H. H., defrosting low temperature evaporators, A135
HAMDY, M. K., microbiological factors in treatment of phenolic wastes, A101
HAMILTON, R. M., making a dry product, A59
HAMMOND, D. M., survival of *Trichomonas foetus* in semen, A55
HANCOCK, J., importance of inheritance and environment in producing dairy cattle, A49; performance of twins uniformly treated after different treatments, A49; value of identical twins in short-term trials, A50; summary of studies in monozygotic cattle twins, A50
HANKINSON, D. J., antibiotics in milk and human intestinal coliform bacteria, A89
HANNI, H. H., "bank"-red in cheese, A30
HANSEN, F. F., milk powder preparation, A30; milk powder and its preparation, A30
HANSEN, R. P., variations in fatty acid composition of butterfat, A69
HANSEN, S. A., mechanical features of plate type HTST pasteurizer, A97; phosphatase inactivation in HTST pasteurization, A97; creaming impairment in HTST pasteurization, A97
HARDISON, W. A., indicators in measurement of dry matter intake, A14
HARPER, W. J., solvent extraction method for estimation of WIA in cream, A88
HARRIS, K. L., testing cream for extraneous matter, A63
HARRIS, L. E., cultured milk powder, A67
HARSTAD, J. B., ultraviolet irradiation in air conditioner, A101
HARSTICK, W. H., milk strainer, A18; milk strainer with removable baffle, A36; continuous milk filling system, A45
HART, F. L., why plant inspection, A58
HASKELL, W. H., bulk milk collection, A152
HASKING, Z. D., effect of variations in hay on fat content of milk, A137
HASSAN, H. A., nonfat solids of cow and buffalo milk, A89
HASSLER, J. B., pricing fat and skim components of milk, A71
HAUGE, S. M., carotene destruction in alfalfa, A16
HAUGH, R. R., press simplifies cheese handling, A4
HAWKING, F., milk diet, p-aminobenzoic acid and malaria, A39
HAYS, R. L., effect of vitamin A deficiency on: I. decidua, ova, and fertilization, A110; II. embryonic and fetal development, A110
HEALD, P. J., viable counts of rumen facultative anaerobes, A6
HEATH, H., radioactive sulfur and ergothioneine formation in pig, A39
HECKENDORF, H. A., regulating device for pipeline milkers, A50; milk can filling attachment, A74; power washing cream separator, A119; milk line flushing system, A138; pressure release valve for milk hose, A151
HEIN, H. W., signaling device for milking machines, A17; diaphragm milk releaser, A107; pressure equalizing device, 107
HEINIG, H., ice cream cone vending machine, A87; A152
HEIZER, E. E., loose housing or stanchion-type barns, A17
HELMBOLDT, C. F., vitamin A depletion time in calves, A52; effects of abnormal machine milking, A56; method of reproducing teat topography, A56
HEMMINGER, R. S., flushing apparatus for milking systems, A107
HENNINGSON, R. W., antibiotics in milk, A22; comparison of Schain and Babcock tests, A117
HENRARD, F. J. J. J., method for thermal treatment of milk products, A52
HENRICI, M., carbohydrate nutrition, A29
HENRY, K. M., sow milk for rats, A23; nutritive value of milk and milk products, A140; vitamin D content of Indian butters, A132
HENSGEN, B. T., cheese curd cutter, A29
HERMAN, H. A., effect of tannins in feeds on milk production, A137
HERRO, A. C., concentrating milk, A30
HESSE, C., foamy beverages, A6
HESSELTINE, W. R., effects of once-daily milking, A138
HESTER, A. S., vitamin B_{12} feed supplement, A72
HIBBS, J. W., relation of mineral contents of milk and pasture herbage, A22
HICKEY, R. J., industrial fermentations, A113
HIGGINBOTTOM, C., bacteriological studies on pasteurized milk, A7
HIGGS, T. M., relationship between mastitis and stripping method, A65
HIGHLAND, H., baits for control of resistant flies, A155
HIGUCHI, K., nutrition of *B. melitensis*, A31
HILL, A. R., valve asembly for milking machines, A139
HILL, C. H., chick-growth stimulation by alfalfa juice, A39
HILL, H. H., door control for milking barns, A74
HILL, I., efficient ice cream packaging, A96
HILLIG, F., rapid estimation of WIA in cream and butter, A119
HIRSH, A., anaerobic spore-formers from cheese, A146
HISCOX, E. R., aroma-producing group "N" streptococci from cheese, A146
HOBINGER, E., malty defect of milk and butter, A151

HOCH, E. G., milk bottle crate, A45
HODGSON, A. S., variation of estimates of forage digestibility, A105
HODSON, A. Z., nutritive value of milk proteins, A89
HOEFLAKE, H., B-vitamin content of Dutch milks, A83
HOEKSTRA, W. G., relationship of vitamin A to hyperkeratosis, A55; production of hyperkeratosis in calves, A55
HOFF, S., changes in diacetyl and plate count of stored butter, A143
HOFFMAN, R. A., chemotherapeutic use of insecticides, A27
HOGLUND, C. R., quality roughage reduces dairy costs, A106
HOLLENDER, H. A., homogenized milk in cornstarch puddings, A51; homogenized vs. nonhomogenized milk for food products, A62
HOLLEY, K. T., determination of free gossypol in feeds, A105
HOLLOWAY, C. G., cow barn gutter cleaner, A50
HOLMAN, R. T., nutritive values of fat, A76
HOMELINK, H. G., method for distinguishing regular and whey butter, A115
HONNE, H., micromethods for trace elements in milk, A117
HOOD, B. J., factors influencing protein synthesis by microorganisms *in vitro*, A7
HOOVER, S. R., aerobic treatment of wastes, A26; terminal amino groups of α- and β- caseins, A31
HOPSON, G., selling milk through vending machines, A120
HORN, M. J., microbial method of determining protein value, A105
HORNSTEIN, I., lindane toxicity to flies, A78; concentrations and exposure time of lindane vapor required to kill insects, A78; chlorinated polyphenols in improving lindane residues, A155
HORTON, J. P., design of milk-waste disposal plants, A53
HOPTON, R., pumping mechanism, A32
HOTCHIN, J. E., staphylococcal bacteriophage K, A117
HOUTMAN, A. C., iodinated casein fraction and milk yield of goats, A89
HOWARD, H. W., infant food, A6; milk protein food product, A30; food product, A116
HUCKER, G. J., adherence of organisms to eating utensils, A63
HUDMAN, D. B., factors influencing protein synthesis by microorganisms *in vitro*, A7
HUFFMAN, C. F., ruminant nutrition, A17
HUGHES, E. W., pulsation and milking rate, A38
HUGHES, M. F., liquid sugar, A36
HUGHES, R. H., dietary protein heat injury, A23
HUMBERT, E. S., testing half and half homogenized milks, A70
HUMPHREY, J. H., source of antibody in milk, A127
HUNGATE, R. E., microbial fermentation in bovine rumen, A136
HUNTER, G. D., biosynthesis of milk-fat from acetate and glucose, A109
HUNTER, J. E., sanitation of farm milk pipelines, A63; bacteriological studies of farm milk handling, A82
HYTTE, R. P. L., plate heat exchanger, A11

IACOBELLIS, M., effect of heat on nutritive value of milk proteins, A23
Ice Cream Trade J., 1953 gallonage, A75; Sealtest markets new flavor, A75; flavor scoreboard, A95; sherbet flavor ratings, A95; trend to night openings by supers, A105
IHDE, K. D., chemical control of cheese mites, A66
IJICHI, K., antibiotic feed supplements, A14
ILLES, G., new advances in sherbets, A96
Industrial and Eng. Chem., modern chemical processes, Vol. III, A115
INGRAM, P. L., nutritive value of colostrum, A25
INNES, R. H., container structure, A148
IRVINE, D. M., patent developments in the cheese industry, 1900-1951, A66
IWAMOTO, K., biochemical studies on kuwazu disease, A2
IYA, K. V., vitamin B_{12} activity of milk, A83
IYER, V., saffron and nutmeg in milk preparations, A82

JACQMAIN, D., antibiotic action of polyunsaturated fatty acids in milk, A125
JAGO, G. R., factors influencing lactic acid production by cheese streptococci, A145
JANES, R. N., mechanical dairy feeder, A106
JANN, G. J., enhancement of antibiotic production, A8
JANOVSKY, H. L., detection of ethylvanillin extract, A118
JANSE, L. C., composition of Friesian milk, A83
JARA, J., casein hydrolysis, A31
JARRIGE, R., carbohydrates in ruminant diets, A16
JARVIC, M., changes in diacetyl and plate count of stored butter, A143
JASEWICZ, L., aerobic treatment of wastes, A26
JELLIFFE, D. B., protein content of human milk, A10
JENKINS, L. P., supply and use of fluid milk, A84
JENNENS, M. G., methyl red test in peptone media, A68
JENNESS, R., effect of heat treatment on serum proteins, A43
JENSEN, C. O., hemicelluloses from orchard grass, A102
JERMSTAD, A., amino acids in Gammelost, A115
JOHANSEN, F. M., apparatus for extrusion filling, A75
JOHNS, A. T., fermentation of glycerol in sheep rumen, A48
JOHNS, C. K., substances in milks inhibiting acid production, A92; iodophors as sanitizing agents, A98
JOHNSON, G. R., steps in plant design, A95
JOHNSON, J., mildew eliminated by new paint, A46
JOHNSON, P. E., manufacture of cream-type cheese from condensed cream, A80; bulk vs. can for handling milk, A152
JOHNSON, S., milk distribution and pricing in Great Britain, A48; market for fluid skimmilk, A85; machine vending of milk, A121
JOHNSON, V. W., effect of water intake on digestibility of hay, A16; effect of variations in hay on fat content of milk, A137
JONES, C. H., effects of feeding hay and cod-liver oil to dairy cattle, A14
JONES, D. L., biology of rope production, A81; influence of physicochemical environment on formation of ropy substance, A84; chemical studies of ropy substance, A81
JONES, J. E., valve assembly for milking machines, A139
JORDAN, R., homogenized milk in cornstarch puddings, A51; homogenized vs. nonhomogenized milk for food products, A62

JORDAN, R. M., thyroprotein for lactating ewes, A111
JORDAN, W. K., maple syrup process in dairy units, A104
JOSEPHSON, D. V., origin of sunlight flavor in milk, A37
JUÁREZ, L., yucca leaves as fodder, A48
JUNGHERR, E. L., vitamin A depletion time in calves, A52

KAG, H., control of acidification in cheese curd, A100
KAHLERT, W. E., evaporative cooling, A10
KAMLET, J., ice cream stabilizer, A37
KAPELLE, D., use of whey paste and powder in silage, A14
KAPLAN, S., cheese cutter, A5
KARR, M. M., portable milk cooler, A138
KARTHA, A. R. S., indicators for detection of hydrogenated oil, A10
KATYAL, R. P., adsorption of benzene vapors, A83
KATZ, J. R., base materials for frozen desserts, A19; A108
KAUFMANN, W., unsaturated acids in milk fat, A103
KAWANAMI, T., antioxygenic action of vitamin C, A6
KEENER, H. A., coarse grain or fine?, A73; limestone lowers silage digestibility, A151
KEENEY, J. O., can puncturing and holding device, A30
KEENEY, M., milk fat adulteration, A70; butterfat research, A119
KELLER, G. J., frozen citrus concentrates, A60
KELLEY, G. G., effect of menadione on milk souring, A52; A108
KENDALL, K. A., effect of vitamin A deficiency on: I. decidua, ova, and fertilization, A110; embryonic and fetal development, A110
KENDRICK, J. F., DHIA program, A17
KENNY, A. D., ethylenediamine tetra acetate method for serum calcium, A101
KESTER, L. T., cottage cheese keeping quality, A92
KIDDER, G. W., biochemistry and physiology of nutrition, A2; biochemistry and physiology of nutrition, Vol. II, A91
KIDDER, H. E., bactericidal activity of the uterus, A106
KIDDER, R. W., minerals for cattle, A123
KIDWELL, J. F., hereditary female sterility in Holsteins, A124
KIEFERLE, F., enrichment of milk in the cow, A23; tocopherol content of cow's milk, A127
KING, H., fly control in dairy barns, A40
KINGSTON, J. A., milking machine, A107
KIRK, W. G., minerals for cattle, A123
KIROV, S. M., transformation of butter during storage, A3; influence of dispersion of dried milk on stability, A6
KITTS, W. D., hydrolytic products of cellulose, A93
KIVENKO, S., enrichment of milk, A23
KLECZKOWSKI, A., inhibition of bacteriophage by chymotrypsin, A116
KLECZKOWSKI, J., inhibition of bacteriophage by chymotrypsin, A116
KLEIBER, M., propionate as precursor of milk constituents, A26
KLEIN, E. F., liquid cheese compositions, A144
KLEIN, H. P., properties of hexokinase of *P. putrefaciens*, A31
KLEIN, R. A., chocolate mix, A75
KLETTE, H., mechanism of hormonal fattening, A39
KLINGZING, A. F., barn gutter cleaner, A86
KNIGHT, S. G., preparing cheese, A29
KNIGHT, T., palletized loading, A47
KNIGHTLY, E. E., spray-type expansible milk cooler, A107
KNODT, C. B., antibiotics in ruminant growth, A17
KOCH, U., control of acidification in cheese curd, A100
KOENEN, K., Weilrell-Stoldt fat determination for milk products, A117
KOLBET, P., sediment trap, A22
KOLTHOFF, I. M., determination of disulfide groups, A68; titration of sulfhydryl groups, A68
KON, S. K., sow milk for rats, A23; nutritive value of colostrum, A25; vitamin D content of Indian butters, A132; nutritive value of milk and milk products, A140
KON, T. K., effect of light on riboflavin in milk, A126
KONCUS, A. F., protein reducing value of milk as indication of nonfat dry milk solids, A9
KONOPLEVA, E., elimination of bitter flavor in cheese, A5
KOOIMAN, P., cellulose from *Myrothecium verrucaria*, A117
KORDTS, E., effect of green fodder and vitamin A on sperm quality, A106
KORN, A. H., terminal amino groups of α and β caseins, A31
KORNILOVA, O., testing cream and cottage cheese for pasteurization of starter, A43
KOSIKOWSKI, F. V., maple syrup process in dairy units, A104; antibiotics in milk, A22; cost of manufacturing Cheddar cheese, A80
KRANJC, I., edible oil and fodder from gourds, A49
KRAVCHENKO, M., laboratory's part in improving milk quality, A52
KREITLOW, K. W., diseases of forage grasses and legumes, A106
KRIENKE, W. A., orange flavor formula, A60
KRISTAL, F. A., pumps, A41
KROGH, N., viable counts of rumen facultative anaerobes, A6
KUGENEV, P. V., influence of rations on amino acid composition of milk, A31
KUNKEL, H. O., factors influencing protein synthesis by microorganisms *in vitro*, A7; serum alkaline phosphatase activity in cattle, A24
KURODA, J., antioxygenic action of vitamin C, A6
KURTZ, L. M., ice cream making plate, A152
KURTZHALTS, W., process of making grated cheese, A115

LAKHANPAL, M. L., adsorption of benzene vapors, A83
LAMMING, G. E., effect of vitamin A deficiency on embryonic and fetal development, A110
LANCASTER, R. J., investigating the faeces of grazing cows, A49
LANDAU, M. A., food product for animals, A106
LANDGRABER, F. A., apparatus for packaging frozen confection, A70
LANG, F., production of graded butter in Switzerland, A3
LARDY, H. A., metabolic functions of biotin, A140
LARKIN, W. H., water-pollution-control program and milk wastes, A28

LASMANIS, J., action of disinfectants on micrococci, A8
LAVRIC, J., albumin in fodder, A49
LAZARUS, N. E., iodine bactericides in the dairy industry, A112
LEATHERS, T. D., milk dispensers, A120; vending ups profits, A120
LECOMTE, J., sympathomimetic activity of organ extracts, A26
LEE, D. H. K., heat tolerance of cows, A24; heat tolerance tests, A24; water evaporation from body surface, A110
LEES, H., effect of heat on nutritive value of milk proteins, A23
LEFEBVRE, B., detection of margarine in butter, A42
LEGGATT, A. G., determination of solids-not-fat in milk, A147; measurement of milk solids by oxidimetry, A147
LEMBKE, A., unsaturated acids in milk fat, A103
LEONE, E., radioactive sulfur and ergothioneine formation in pig, A39
LEROY, A. M., analyses of animal feeds, A16
LERSTAD, O., multiple sclerosis in Norway, A39
LETARD, E., pressed vs. extracted linseed cakes as feed, A49
LEVENS, E., determining densities of viscous fluids with Babcock bottles, A31
LEVIN, Y., specific gravity of reconstituted skimmilk, A133
LEVY, H. E., screening of aralen dihydrochloride activity against *Anaplasma marginale*, A2
LEWANDOWSKI, T., using acid cleaners, A62; alkaline cleaners for HTST pasteurizers, A128
LEWIS, J. C., antibiotic feed supplements, A14
LEWIS, S. J., machine for inserting containers in cases, A148
LIES, T., JR., action of aliphatic thiocyanate against fly, A27
LIGNAC, J., detection of antibiotics in milk, A22
LILLEVIK, H. A., electrophoretic patterns of fat membrane proteins, A9
LIND, C., distribution of types of lactic acid bacteria, A146
LINDQUIST, A. W., chemotherapeutic use of insecticides, A27
LINDQUIST, B., chromatography of amino acids in cheese, A147; chromatography of volatile acids in cheese, A147
LING, E. R., reviews of progress in dairy science, chemistry, A68
LISKA, B. J., sediment testing of bulk milk, A88; influence of agitation on Babcock test of bulk milk samples, A76
LITSKY, W., comparison of numbers of coliform bacteria and enterococci in raw sewage, A27
LIVINGSTON, A. L., xanthophylls in alfalfa, A93
LOCKHART, H. B., milk substitute, A88
LONCIN, M., antibiotic action of polyunsaturated fatty acids in milk, A125
LONGHI, S., high-protein animal feed, A16
LOOS, H., copper and Cheddar flavor, A43
LOOSLI, J. K., antibiotics in ruminant nutrition, A59
LOUW, J. G., Lucerne hay digestibility, A16
LOVELL, R., nutritive value of colostrum, A25
LUCAS, E. R., self-service sales of pre-dipped bulk, A125
LÜCK, H., treating milk with oxygen, A109; bacteria increase under oxygen pressure, A109
LUCKEY, R. F., JR., dairy industry in Florida, A104
LUCKMANN, F. H., spectrophotometric determination of sorbic acid, A57; migration of sorbic acid into cheese, A57; resistance of sorbic acid to oxidation, A57; metabolism of sorbic acid by molds, A57
LUEDICKE, A. H., JR., bottle carrying pocket, A28
LUGT, T. V., JR., bottle carrier, A85
LUND, C. O., frozen stick confections, A18
LUSK, J. W., winter pasture for dairy feed, A15
LUTERICK, M. C., ice cream packaging machine, A103
LUTSEY, T. H., forming head for ice cream tarts, A20

MACADAM, I., cells in bovine milk, A65
MACGREGOR, D. R., effect of hypochlorite on detergent activity of alkaline cleaners, A112
MACORMACK, J. G., vapor barrier, A103
MACVICAR, R., placental transfer of vitamin A and carotene by cows, A39; digestibility of prairie hay, A105; metabolism stall for steers, A111
MADDEN, W. H., frozen confection sandwich container, A107
MAEDA, T., powdered lactic acid beverage, A6
MAGALOS, A. C., bottle capping machine, A45
MAGEE, A. C., clover to cut production costs, A48
MAHANTA, K. C., variation of estimates of forage digestibility, A105
MAHON, J. H., detection of adulteration of butter, A134
MAHONEY, G. W. A., grade "A" milking parlor, A18; portable milking barn, A152
MAIR, W. H., new ideas, A27
MAISSIAN, A. D., dairy product and process, A89
MAKAR'IN, A., humidity and distribution of salt in cheese, A5
MALM, O. J., physiology of calcium metabolism, A24
MALMGREN, H., characteristics of testicular hyaluronidase, A39
MALPRESS, F. H., sugar-phosphate esters of milk, A110
MANDERSLOOT, J. G., detection of preservatives in milk, A82
MANERY, J. F., water and electrolyte metabolism, A141
MANGAN, G. F., effectiveness of lindane vaporizers, A27
MANGANO, P. D., inanimate cow milk dispenser, A72
MANKE, A., cold milk separation, A20
MANN, S. O., viable counts of rumen facultative anaerobes, A6; facultative anaerobic bacteria from sheep's rumen, A67; lactobacilli from rumens of calves, A145
MANN, T., radioactive sulfur and ergothioneine formation in pig, A39
MANTEL, N., methods of preparation and use of methylene blue stain for counts, A100
MARCH, R. P., maple syrup process in dairy units, A104; farm bulk milk handling, A138
MARKLEY, R., milk cooler, A17; milk tank cooler, A151
MAROTTA, C. R. C., volumetric determination of chlorides in milk, A44
MARQUARDT, J. C., sanitation in quality cheese production, A42; A43
MARSH, H., experimental tocopherol deficiency in calves, A137
MARSHALL, S. P., millet pasture for cattle, A14

MARSTON, H. R., copper deficiency in ruminants, A25
MARTH, E. H., sanitation of farm milk pipelines, A63; bacteriological studies of farm milk handling, A82
MARTIN, H. W., capping machine control mechanism, A45
MARTIN, J., new chemicals in preparing silages, A49
MARTIN, W. H., low fat high solids mixes, A18
MARTIN, W. McK., apparatus for filling containers, A70; preserving products in sealed containers, A136
MARTIN, W. W., feed dispenser, A138
MARTINEK, M. J., detection of vegetable gums in dairy products, A83
MASSON, F. M., viable counts of rumen facultative anaerobes, A6; facultative anaerobic bacteria from sheep's rumen, A67
MATHIS, M., putrescibility of dairy sewage, A28
MATTSON, N., printing fresh butter, A29
MAYMONE, B., nutritive value of carob, A49
MAYNARD, E. D., calf weaning halter, A86
MAYNARD, L. A., total digestible nutrients measure feed energy, A14
MAZE, H., continuous vitamin fortification of milk, A127
MAZOKHINA, N., manufacture of curds in all-metal equipped plant, A5
MCBRIDE, C. G., formulas for pricing milk, A38
MCCABE, J. B., bottle carrying pocket, A28
MCCARTHY, E. F., absorption of immune globulin by lamb after ingestion of colostrum, A40
MCCAW, W. N., variations in fat percentage, A86
MCCOLLOCH, R. J., frozen citrus concentrates, A60
MCCORMICK, J. A., hereditary female sterility in Holsteins, A124
MCCRARY, M. J., nipple for calf feeding buckets, A74
MCCULLOUGH, M. E., suitability of winter forages for cattle, A34; grazing behavior of cows, A48; forage for calves, A137
MCDONALD, L. E., essentiality of bovine corpus luteum, A25; retained placenta, A62
MCDOUGALL, E. I., absorption of immune globulin by lamb after ingestion of colostrum, A40
MCDOWALL, F. H., quality of non-washed butter, A42
MCDOWELL, R. E., heat tolerance of cows, A24; heat tolerance tests, A24; water evaporation from body surface, A110
MCDUFFIE, W. C., toxicity of vapors to house flies, A27
MCGEOWN, M. G., sugar-phosphate esters of milk, A110
MCGLASSON, E. D., influence of silage on milk flavor, A14
MCINTIRE, J. M., dairy products for military subsistence, A13; influence of lipids on dispersion of milk powder, A133
MCKAIN, W. C., JR., hired workers on dairy farms, A18
MCKEEBAN, H., metabolism of sorbic acid, A57
MCNUTT, S. H., essentiality of bovine corpus luteum, A25; retained placenta, A62
MCPHERSON, W. K., dairy industry in Florida, A104
MCQUILLAN, M. T., enzymic iodination of milk proteins, A68
MCWILLIAMS, J. C., JR., six to twelve, A51
MEAD, M., relationship of lactose to chlorides in milk, A31; assessing cleaning efficiency of detergents, A40
MEADE, R. E., drying lacteal fluids, A5
MEARA, M. L., component acids of whole milkfat, A118
MEEWES, K. H., antibiotics in raw milk, A109
MEHLTRETTER, C. L., sequestration by sugar acids, A53
MELLON, E. F., terminal amino groups of α- and β- caseins, A31
MELNICK, D., spectrophotometric determination of sorbic acid, A57; migration of sorbic acid into cheese, A57; metabolism of sorbic acid by molds, A57; resistance of sorbic acid to oxidation, A57
MENDELSOHN, F. Y., detection of algin and gums in cacao products, A117
MERLIN, D., schedule sales plan for greater gallonage, A61
MERRILL, C. W., freezer converter, A148
MERRIT, T. W., milk release apparatus, A86; milking apparatus, A107
MERTEN, D., determination of fat and water in milk powder, A103; grey discoloration of coffee caused by milk, A109
METZGER, H. B., cost of pasteurized milk, A84; location the key to vending success, A120
MILES, J. T., winter pasture for dairy feed, A15
MILLAR, P. G., manual of infertility and artificial insemination of cattle, A41
MILLER, I. C., profit sharing, A104
MILLER, J. G., screening of aralen dihydrochloride activity against *Anaplasma marginale*, A2
MILLER, M. F., agriculture and the people, A71
MILLER, R. A., tests for adulteration of human milk, A10
MILLER, V. L., manure conveyor, A86
MILLER, W. C., radiation sterilization of foods, A101
MILOSERVIC, S., antibiotics in raw milk, A109
MILYUTINA, L., manufacturing dietetic sour dairy products, A52
MINAGAKI, S., hypoglycemia and insulin ketosis in goats, A26
MINER, M. L., survival of *Trichomonas foetus* in semen, A55
MINOCK, R. M., calf puller, A152
MIOLLIS, R., cheese making method, A5
MIRONOVA, N., enrichment of sour-milk products, A23
MITCHELL, H. H., determination of metabolic fecal nitrogen, A110
MITCHELL, H. L., carotene determination in alfalfa meal, A9
MITCHELL, J. H., JR., effect of calcium removal on properties of milk, A135
MITCHELL, K. G., sow milk for rats, A23
MITLIN, N., fly toxicity of methyl and ethyl analogs of allethrin, A155
MITTELSTADT, C. A., advertising dairy products, A121
MITTEN, H. L., JR., HTST timing with homogenizers, A31
MOBERG, R., disease in fallopian tubes and ovarian bursae of cattle, A79
MOCHRIE, R. D., effect of aureomycin supplement on calf growth, A15; effects of abnormal machine milking, A56; method of reproducing teat topography, A56; effects of once-daily milking, A138
MOFFETT, F. W., apparatus for converting hard frozen confection to plastic state, A51
MOFFETT, W. W., supply and use of fluid milk, A84

MOHAZZEB, M., phosphatase test and international phosphatase unit, A102
MOHR, E., adhesion of detergents, A112
MOHR, W., estimation of copper in dried milk, A102; determination of fat and water in milk powder, A103; grey discoloration of coffee caused by milk, A109; adhesion of detergents, A112; Weilrell-Stoldt fat determination for milk products, A117
MONROE, C. F., linseed oil meals for cows, A15
MONROE, R. A., effect of phenothiazine on thyroid uptake of radioiodine, A111
MONZINI, A., vitamin B_2 content of cheeses, A43
MOOR, H., determination of vitamin E in food, A31
MOORE, A. V., in-place cleaning of pasteurizing equipment, A77
MOORE, C. M., can washing and liquid feeding device, A149
MOORE, L. A., carotenoid loss in farm stored, dried alfalfa, A15; harvesting and preserving forages, A17; liver stores of carotenoids and vitamin A in calves, A23; vitamin A depletion time in calves, A52
MOORE, S., amino acid composition of papain, A118
MOORE, S., III, fly repellent tests on cattle, A154
MORDOVINA, O., fat test of milk, A10
MOREY, G., cultured and fermented milks, A43
MORI, I. K., margarine and reproduction of mouse, A23
MORQUER, R., *Galega officinalis*, poisonous plant, A26
MORREN, L., titration of sulfhydryl groups, A68
MORRIS, A. J., selling milk through vending machines, A120
MORRIS, H. H., keeping quality of pasteurized milk as influenced by psychrophiles and aureomycin, A6
MORRIS, S. G., mechanism of fat oxidation, A44
MORRISON, R. A., variations in fat percentage, A86; improving accuracy of lactation testing, A86
MORROW, K. S., factors influencing milk yield, A22
MORROW, R. R., poison for thornapple, A50
MORTON, R. K., enzymic iodination of milk proteins, A68; association of milk phosphatase with lipoprotein complex, A118; purification of milk phosphatase, A118
MOSER, F. T., nozzle for packaged sundaes, A19
MOSSEL, D. A. A., detection of preservatives in milk, A82
MROWETZ, G., control of acidification in cheese curd, A100
MUCHA, T. J., selectively hydrogenated butter oil, A125
MUKHERJEE, N. C., *Themeda quadrivalvis* as cattle feed, A16; Joy-Joha grass as cattle feed, A34
MULDER, H., melting and solidification of milk fat, A21; measuring temperature in steel cap pasteurizer, A89; churning in absence of foam, A143
MULLER, J. F., infant food, A6
MULLETT, P. A., relation of Q-fever to dairy products, A1
MUMM, H., determination of bromates in milk, A148
MÜNCH, V., secretions of androgens and estrogens in milk, A111
MUNRO, P., fishiness in butter, A132
MURDOCK, F. R., variation of estimates of forage digestibility, A105
MURRAY, C. H., cattle insecticide applicator, A53
MUSSEHL, F. E., chick-growth stimulation by alfalfa juice, A39
MYBURGH, S. J., Lucerne hay digestibility, A16
MYERS, G. L., churn, A80
MYKLEBY, R. W., greater yields of cottage cheese, A57

NAKANISHI, T., antioxygenic action of vitamin C, A6
NAMBUDRIPAD, K. N., vitamin B_{12} activity of milk, A83
NANDI, D. K., processing and nutritive value of vegetable milk, A43
NATSCHEV, L., antibiotic properties of cheese, A100
NAUROTH, L. J., apparatus for producing frozen confections, A70
NEAVE, F. K., relationship between mastitis and stripping method, A65
NELSON, A. B., metabolism stall for steers, A111
NELSON, C. H., stock waterer, A35
NELSON, C. K., machine for frozen confections, A87
NELSON, F. E., calcium and related ions in proliferation of lactic streptococcus bacteriophage, A6; influence of time and temperature on bacterial counts of milk, A82
NELSON, G. L., grade "A" milking parlor, A18; portable milking barn, A152
NELSON, G. T., economic analysis of butter-nonfat dry milk plants, A13
NELSON, J. R., flavor in butter, A98
NELSON, W. O., influence of metabolites on p-aminobenzoate-pantothenate interaction in *B. linens*, A7; nutritional equivalence of pantothenate and p-aminobenzoate for *B. linens*, A7
NEVILLE, W. E., JR., suitability of winter forages for cattle, A34; grazing behavior of cows, A48
NEWELL, G. W., feeding fluorine to cattle, A105
NEWLAND, L. G. M., serological typing of group N streptococci, A7
NEWLANDER, J. A., effects of feeding hay and cod-liver oil to dairy cattle, A14
NICHELE, G., nicotinic acid in human milk, A31
NICHOLS, R. E., essentiality of bovine corpus luteum, A25; retained placenta, A62
NICOLAYSEN, R., physiology of calcium metabolism, A24
NIELSEN, J., influence of tocopherol on milk yield and milk fat, A33
NIKITIN, V. N., biochemistry of lactation, A39
NOBILE, S., determination of vitamin E in food, A31
NORD, F. F., advances in enzymology, Vol. 15, A98
NORRIS, L. F., bulk milk transporting and dispensing apparatus, A122
NORTH, G. C., chocolate mix, A75
NOVILLI, G. D., metabolic functions of pantothenic acid, A140
NOZNICK, P. P., chocolate mix, A75
NURMIKKO, V., biosynthesis of amino acids and vitamins in associations of lactic acid bacteria, A101

O'DEA, J. J., quality of non-washed butter, A42
OGLESBY, W. T., screening of aralen dihydrochloride activity against *Anaplasma marginale*, A2
OKAMOTO, M., magnesium determination in bovine blood serum, A102
OLDENBURG, E. C., container closure, A17

OLDS, D., reproductive efficiency in cattle, A106
OLIVER, J., relationship between mastitis and stripping method, A65
OLSON, H. C., manufacture of cream-type cheese from condensed cream, A80; bulk vs. can for handling milk, A152
OLSON, J. C., JR., keeping quality of pasteurized milk as influenced by psychrophiles and aureomycin, A6
OLSON, R. E., marketing costs, A122
OLVER, E. F., mechanical dairy feeder, A106
OPDYKE, M., effects of anterior hypophysis on mammary glands, A26
OSIPOW, L., cleaning of diphase and emulsion systems, A53
OTA, H., mammary gland phosphatases, A26
OVERBY, A. J., nebraecetin-secretion and effect in milk, A81
OWENS, A. L., costs and returns on dairy farms, A18
OXFORD, A. E., viable counts of rumen facultative anaerobes, A6; facultative anaerobic bacteria from sheep's rumen, A67; lactobacilli from rumens of calves, A145
OYAERT, W., uptake of plasma amino acids by cow udder, A26
OZMINA, W. E., valve mechanism for flushing pipe line milking systems, A128

PAGE, J. M., new cheese salt, A100
PALAZZOLO, V., automatic butter server, A29
PANASENKOV, N., influence of dispersion of dried milk on stability, A6
PAPPENHEIMER, J. J., passage of molecules through capillary walls, A25
PARKER, G. S., skeletal maturation of children, A23
PARKER, J. B., dairy cattle breeds, A152
PASCOE, J. V., composition of kangaroo milk, A31; assessing cleaning efficiency of detergents, A40
PASSMORE, R. S., device for testing teat cup inflations, A151
PATTERSON, C. H., weaner, A74
PATTON, S., origin of sunlight flavor in milk, A37
PAULS, D. E., cost analysis of milk handling on farms, A17
PEANASKY, R., metabolic functions of biotin, A140
PEDERSON, A. H., influence of tocopherol on milk yield and milk fat, A33
PEEBLES, D. D., centrifugal atomizer, A5; reconstituted milk process, A22; desiccating apparatus, A84
PEETERS, G., uptake of plasma amino acids by cow udder, A26; sympathomimetic activity of organ extracts, A26
PELTOLA, E., effect of oxidizing salts on Emmentaler cheese, A144
PERCIVAL, J. C., investigating faeces of grazing cows, A49
PERKINS, A. G., control unit for milking machines, A74
PERLMANN, G. E., phosphorus linkages in α-casein, A147
PERRIN, D. R., composition of sow's milk during course of lactation, A69; estimation of energy of sow's milk, A69; variations in fat content of human milk, A139
PERRY, J. R., economics of in-place cleaning, A52
PESCH, W. A., JR., artificially dried grass, A49
PETERS, F. E., chemical composition of human milk, A10
PETERS, H., livestock production, A131
PETERSEN, W. E., methylene blue milk for assay of antibiotics, A134
PETERSON, E. E., timing milk production, A86
PETERSON, H., cold storage plant design, A11
PETERSON, O. N., milk bottle carrying device, A104; carrier for paper milk cartons, A104
PETERSON, W. R., milk measuring and feeding device, A11
PETRI, H., milking structure, A152
PETTE, J. W., cold storage experiments on butter, A143
PEYTON, N. I., variegated ice cream apparatus, A75; method of making variegated ice cream, A152
PHILIPPE, J., animal protein factor, vitamin B_{12}, and antibiotics in feeding animals, A34
PHILLIPS, D. S. M., apparatus for drawing milk ejection curves, A38; tympanometer for measuring intramammary pressure, A139
PHILLIPS, P. H., production of hyperkeratosis in calves, A55; relationship of vitamin A to hyperkeratosis, A55
PHILLIPSON, A. T., cellulose digestion by ruminants, A123
PICKUP, J., fatal hypocalcaemia-like syndrome in cows, A79
PIE, J., waste water in the dairy industry, A128
PIEN, J., detection of antibiotics in milk, A22; detection of margarine in butter, A42
PIERCE, C. W., distributor knowledge of state milk control in Pa., A11; producer knowledge of state milk control in Pa., A12; consumer knowledge of state milk control in Pa., A12; specifications and costs for a milk plant, A47
PIERCE, E. C., method of destroying grubs on cattle, A151
PIFER, C. W., colorimetric determination of ascorbic acid, A147
PINSKY, A., determination of fat in soft cheese, A43
PIPER, P. E., quality in soft freezer dessert, A62
PIROZAK, R. P., method of reproducing teat topography, A56
PLASTRIDGE, W. N., Connecticut mastitis-control program, A1; effects of abnormal machine milking, A56
PLATTS, B., cheese cutter, A5
POLLOCK, R. H., shifts in milk and cream production, A136
POLSON, A., comparative electrophoretic studies of colostrum, A40
POPE, L. S., placental transfer of vitamin A and carotene by cows, A39
POPJAK, G., biosynthesis of fatty acids from carboxy-C^{14} acetate, A39; biosynthesis of milk-fat from acetate and glucose, A109; incorporation of acetate into lactose and glycerol by the udder, A110
POPOV, A. M., vitamin concentrates and cobalt salts in feeding cattle, A34
PORGES, N., aerobic treatment of wastes, A26
POST, W. R., merchandising machine for frozen comestibles, A76
POTTER, F. E., in-place cleaning of pasteurizing equipment, A77
POTTER, N. N., calcium and related ions in proliferation of lactic streptococcus bacteriophage, A6
POU, J. W., effect of glucose injections on milk production, A110
POULSEN, R., treating dairy waste water in septic tanks, A128

PRANGE, L., influence of tocopherol on milk yield and milk fat, A33
PRATT, A. D., linseed oil meals for cows, A15
PRENTICE, J. H., electrical resistance and keeping quality of butter, A131
PRESCOTT, J. M., utilization of nonprotein nitrogen by rumen microorganisms, A39
PRESTON, H. J., distributor knowledge of state milk control in Pa., A11; producer knowledge of state milk control in Pa., A12; consumer knowledge of state milk control in Pa., A12; economic analysis of butter-nonfat dry milk plants, A13
PRICE, W. V., late gas defect in ripening cheese, A30; chemical control of cheese mites, A66; patent developments in the cheese industry, 1900-1951, A66
PRITCHARD, N. T., expectations and plans of milk producers, A71
PROCTOR, B. E., cathode rays and the dairy industry, A9; radiation sterilization of foods, A101
PROUTY, C. C., storage of lactic streptococci, A8
PUNTRIANO, G. O., qualitative study of bull semen, A25
Purdue Agr. Expt. Sta., outer-market distribution of milk, A150
PURI, B. R., adsorption of benzene vapors, A83
PURKO, M., nutritional equivalence of pantothenate and p-aminobenzoate for *B. linens*, A7
PUTNAM, P. L., hired workers on dairy farms, A18

RAADSVELD, C. W., bitter compounds of cheese, A143; Edam cheese ripening, A144
RAGSDALE, A. C., environmental physiology, A24
RAITHBY, J. W., improving ease of reconstitution of skimmilk powder, A92
RAJAGOPALAN, R., processing and nutritive value of vegetable milk, A43
RALSTON, H. P., fly control in dairy barns, A40
RAMACHANDRAN, K. S., determination of milk solids, A83
RAMSEY, L. L., dehydroacetic acid in cheese, A115
RAND, W. E., feeding fluorine to cattle, A105
RAPP, E. J., butter print mold, A143
RAS, N. P., manual of infertility and artificial insemination of cattle, A41
RASMUSSEN, F., JR., HTST mix operations, A96
RASMUSSEN, G. R., animal operated stock oiler, A74
RASMUSSEN, P. O. H., microdetermination of quaternary ammonium compounds, A68
RAO, R. V., determination of milk solids, A83
RAWSON, E., pulsator, A36; suspended milker, A36
RAY, J. H. B., nutritive value of colostrum, A25
RAYMAN, C. J., apparatus for treating liquids, A45
REDDISH, G. F., antiseptics, disinfectants, fungicides, chemical and physical sterilization, A65
REED, L. J., metabolic functions of thiamine and lipoic acid, A140
REID, J. T., indicators in measurement of dry matter intake, A14; antibiotics in ruminant nutrition, A59
REINART, A., determining reconstituted milk in milk colorimetrically, A117
REISS, O. K., mammary synthesis of lactose from glucose, A128
REMALEY, R. J., protein reducing value of milk as indication of non-fat dry milk solids, A9
RESUGGAN, J. C. L., detergents and milk tests, A10
REYNOLDS, M., plasma and blood volumes in cow, A26
RICE, R. G., frozen citrus concentrates, A60
RICHARDSON, C. J., livestock sprayer, A138
RICHARDSON, G. A., effect of hypochlorite on detergent activity of alkaline cleaners, A112
RIEGEL, G. M., corrosion of stainless steel, A111
RIMINGTON, C., radioactive sulfur and ergothioneine formation in pig, A39
RIST, C. E., sequestration by sugar acids, A53
RITTER, W., behavior of phosphatase during pasteurization, A126; oxidation of cheese-dairy butter, A143
RIVALS, P., *Galega officinalis*, poisonous plant, A26
ROAHEN, D. C., HTST timing with homogenizers, A31
ROBERTS, C. G., low carbohydrate ice cream, A87
ROBERTS, R. B., milk advertising, A121
ROBERTS, W. M., cold milk separation, A126
ROBERTSON, A. H., methods of preparation and use of methylene blue stain for counts, A100
ROBERTSON, J. W., process control for ice cream, A75
ROBORGH, J. R., iodinated casein fraction and milk yield of goats, A89
RODGERS, N. E., whey products and process of manufacture, A5
RODMAN, F. C., mouthpiece for cap magazines, A45
ROEDER, G., sensitiveness of milk proteins, A117
ROELOFSEN, P. A., cellulase from *Myrothecium verrucaria*, A117
ROESSLER, E. B., errors in organoleptic difference testing, A80
ROINE, P., evaluating artificial human milk, A154
ROLAND, C. T., thickening and stabilizing agents, A37
ROLAND, J. F., JR., quantitative paper chromatography of amino acids, A68; quantitative determination of amino acids, A82
ROLAND, T. D., vacuum tank with pipe line milking, A35
ROLLIN, N. J., effectiveness of sorbic acid in protecting cheese, A57
ROMANOVICH, T., manufacturing dietetic sour dairy products, A52
RONAI, K. S., proteins for latex paints, A80
ROSE, D., effect of freezing rate on frozen milk stability, A96; estimation of protein denaturation in frozen milk, A97; titration curves of whey constituents, A135
ROSENBAUM, M. J., comparison of numbers of coliform bacteria and enterococci in raw sewage, A27
ROSENHAHN, W., nutritive value of tobacco seed extraction in cows, A34
ROSS, C. A. C., hexosamine in human and cow milk, A10
ROSS, O. B., carotene and vitamin A metabolism in cattle, A23
ROSS, O. E., citrus-flavored sherbets, A51
ROSS, O. P., wire mesh conveyor belts, A70
ROSSLANDER, M., evaluating artificial human milk, A154
ROSTENBERG, A., JR., mechanisms of cutaneous drug reactions, A49
ROTH, A. R., chemotherapeutic use of insecticides, A27
ROUSSEAU, J. E., JR., carotenoid loss in farm stored, dried alfalfa, A15; liver stores of caro-

tenoids and vitamin A in calves, A23; vitamin A depletion time in calves, A52
ROVERTS, C. G., low carbohydrate ice cream, A74
ROWLAND, S. J., ionic and lactose concentrations of milk, A10; A127; effect of concentrate protein on fat content of milk, A137; effect of variations in hay on fat content of milk, A137
RUBY, E. S., pH of the bovine rumen, A111
RUDOLFS, WILLEM, industrial wastes, their disposal and treatment, A3
RUF, E. W., factor stimulatory to cellulose digestion in lambs, A13
RUPPERT, G. E., stabilizing device for ice cream tubs, A139
RUSOFF, L. L., antibiotic studies with calves, A73
RZHEVSKAYA, T. K., methods of studying cow urine, A39

SAARINEN, P., relation of blood mineral composition and the milk yield, A25; study of mineral constituents of blood of cows, A26
SACCO, V., chemical reaction for detecting abnormal composition of milk, A26
SAFFORD, J. W., experimental tocopherol deficiency in calves, A137
SAGE, T. L., bulk milk transporting and dispensing apparatus, A122
SALISBURY, G. W., effect of vitamin A deficiency on: decidua, ova, and fertilization, A110; embryonic and fetal development, A110
SALLE, A. J., enhancement of antibiotic production, A8
SALWIN, H., biuret method for soluble whey proteins, A83
SAMUELSON, E. G., printing fresh butter, A29; chemicals against tin taste in milk, A52
SANCHEZ, H. L., millet pasture for cattle, A14
SANDERS, T. H., nutrition of *B. melitensis*, A31
SARMA, P. S., preparation of dephosphorized casein, A82
SATO, A., pyruvic acid and acetaldehyde in human milk, A31
SATTLER, B., calcium lactate, calcium glycerophosphate solution, A2
SATTLER, G., JR., calcium lactate, calcium glycerophosphate solution, A2
SAVAGE, K. G., increasing homogenizer capacity, A51; viscosity of cream, A51
SAYRE, J. D., relation of mineral contents of milk and pasture herbage, A22
SCALES, F. M., can washing and sterilizing process, A149
SCAUT, A., determination of phosphatase in milk, A10
SCHALIN, O. W., shedding characteristics and occurrence of mastitis, A1; *M. pyogenes* in milk, A8
SCHARPENSEEL, H. W., vitamin content of raw food, A49
SCHEELJE, R., extermination of brucellosis, A99
SCHENK, T. C., brine tank elevator, A11
SCHICKS, G. C., liquid cheese compositions, A144
SCHINDLER, H., orange peels in cattle feeding, A16
SCHIPPER, I. A., methylene blue milk for assay of antibiotics, A134
SCHMALL, M., colorimetric determination of ascorbic acid, A147
SCHMIDT, H. J., feeding fluorine to cattle, A105
SCHNEIDER, C. L., reefer's function keyed to refrigeration, A11
SCHOLS, J. C., churning in absence of foam, A143
SCHROEDER, L. J., effect of heat on nutritive value of milk proteins, A23
SCHUH, W. R., bending pipe cuts costs, A32
SCHULZ, M. E., control of acidification in cheese curd, A100
SCHULZE, K. L., aerators for cheese-waste, A155
SCHULZE, W. G., curd mill, A145
SCHWARDT, H. H., biological studies of horse flies, A77; fly repellent tests on cattle, A154
SCHWARZ, G., determination of bromates in milk, A148
SCHWARZKOPF, V., milk fat blending apparatus, A11; milk can's future, A47
SCHWEIGERT, B. S., animal fats in feed, A16; effect of fats on vitamin A stability, A59
Scientific Committee (Neth.), determination of density of milks, A116
SCOTT, E. C., concentrated milk proteins in dairy industry, A5
SCOTT, J. K., transfer of heat in milk cooler, A22; moisture loss in Cheddar cheese, A132; surface milk coolers for farms, A138
SCOTT, W. A., airtight milking machine, A50
SEARS, H. J., nutritive value of colostrum, A25
SEATH, D. M., reproductive efficiency in cattle, A106
SEELY, D. H., vanilla-like synthetic flavor, A60
SEGURA, G., JR., cleaning of disphase and emulsion systems, A53
SEIBERLING, D. A., dairy paints, A46; dual operation of HTST pasteurizer, A96
SEKINE, T., metabolism of acetylcholine in animal spermatozoa, A26
SELL, O. E., suitability of winter forages for cattle, A34; grazing behavior of cows, A48
SELLERS, A. F., biochemical and toxic effects of salts on calves, A24
SELLES, E., hydrolysis of casein, A31
SEMMETT, W. F., amino acid composition of γ-casein, A31
SEN, B., *Themeda quadrivalvis* as cattle feed, A16
SERRANO, J. F. V., changes produced in milk by adding water, A31
SEUSS, A., tocopherol content of cow's milk, A127
SEVALL, H. E., milk protein food product, A30
SHAND, E. B., industrial glass piping, A77
SHARON, N., specific gravity of reconstituted skimmilk, A133
SHARP, L. P., reducing costs of raising calves, A138
SHAW, A. O., variations in fat percentage, A86; improving accuracy of lactation testing, A86
SHAW, J. C., effect of glucose injections on milk production, A110
SHEBANIN, P., transformation of butter during storage, A3
SHEETS, W. D., microbiological factors in treatment of phenolic wastes, A101
SHEFFIELD, H. B., high-temperature pasteurization of ice cream mix, A18
SHEPHERD, A. D., pectin production, A19
SHEPHERD, J. B., harvesting and preserving forages, A17
SHERRER, E. L., microbiological factors in treatment of phenolic wastes, A101
SHEURING, J. J., cleaning glass lines in place, A40; retail sanitation study, A60
SHIBATA, A., hypoglycemia and insulin ketosis in goats, A26
SHILOVICH, M., testing cream and cottage cheese for pasteurization of starter, A43
SHORLAND, F. B., variations in fatty acid composition of butterfat, A69

SHURTS, E., teat cup inflation, A151
SIEDLER, A. J., effect of fats on vitamin A stability, A59
SIEGFRIED, H., control of acidification in cheese curd, A100
SIEIRO, F., *Brucella* immunity studies, A131
SIERENS, G., uptake of plasma amino acids by cow udder, A26
SILBERBERG, M., effects of anterior hypophysis on mammary glands, A26
SILBERBERG, R., effects of anterior hypophysis on mammary glands, A26
SILKER, R. E., carotene determination in alfalfa meal, A9
SILVERMAN, G. J., antibiotics in milk, A22
SIMON, J., bactericidal activity of the uterus, A106
SIMONART, P., improvement of milk quality by ultracentrifugation, A8
SIMONET, R. A., coating chocolate bars, A50; chocolate coated ice cream bars, A75
SIMONNET, H., biochemistry of phosphorus compounds of milk, A39
SIMPSON, D., relationship between mastitis and stripping method, A65
SINGH, H., variations in milk from different quarters of udder, A89
SINGLETON, A. G., ruminant digestion, A25
SINGLETON, J. A., quality of non-washed butter, A42
SIRNY, R. J., digestibility of prairie hay, A105
SKADHAUGE, K., microdetermination of quaternary ammonium compounds, A68
SKELTON, F. M., standardizing half-gallon container, A37; time and motion studies in ice cream plants, A87
SKETT, H. E., teat cup, A74
SKINNER, W., sample with quarts, A32
SLATER, J. E., Kraft's package lab, A93
SMALTZ, J. J., double stage sediment tester, A109
SMITH, A. H., effect of heat on nutritive value of milk proteins, A23
SMITH, D. D., effect of K and λ-carrageenins on milk viscosity, A97
SMITH, D. P., effectiveness of sorbic acid in protecting cheese, A57; cheese packaging, A115
SMITH, J. V., Connecticut mastitis-control program, A1
SMITH, R. T., consumer satisfaction from packaged ice cream, A36; consumer preference in ice cream, A61; reducing operating costs, A104
SMITH, V. N., modernizing cuts cheese costs, A58
SMYTHE, H. F., JR., harmlessness of sorbic acid, A57
SNELL, C. T., comparative cleaning of diphase and emulsion systems, A53
SNELL, E. E., metabolic functions of nicotinic acid, riboflavin, and vitamin B_6, A140
SNELL, F. D., comparative cleaning of diphase and emulsion systems, A53
SNELL, N. S., antibiotic feed supplements, A14
SNODGRASSE, R. M., skeletal maturation of children, A23
SOLBERG, P., serological detection of cow milk in goat milk, A126
SOMERS, H. L., millet pasture for cattle, A14
SOMMER, W. A., food product, A116
SONI, B. F., variation in estimates of forage digestibility, A105
SPENCER, G. R., action of disinfectants on micrococci, A8
SPENCER, H. S., sampling dipper, A45
SPENCER, L., milk distribution and pricing in Great Britain, A48; specifications and costs for a milk plant, A47
SPIES, T. D., skeletal maturation of children, A23
SPIESS, N. E., JR., beater mechanism, A20; pumping mechanism, A32; closure for containers, A70; container for frozen products, A125; whipped cream dispenser, A126
SPROSS, H. M., separator for cold milk products, A22; A45
SPUR, B., vitamin D in fortified milk, A23
SPURLOCK, A. H., productive life-span of dairy cattle, A124
SREENIVASAMURTHY, V., vitamin B_{12} activity of milk, A83
STADIE, W. C., current concepts of action of insulin, A141
Staff, Food Eng., kaseferteger mechanical cheesemaker, A92
STALLCUP, O. T., pH of the bovine rumen, A111
STAMM, G. W., artificial breeding and livestock improvement, A114
STAMPEN, J. J., inflation for milkers, A74
STANLEY, P. G., enzymic iodination of milk proteins, A68
STANSBURY, R. E., new fly repellents, A154
STARK, F. H., food product flavoring composition, A67
STERNBERG, J., biochemistry of phosphorus compounds of milk, A39
STIMPSON, E. G., frozen concentrated milk products, A43; conversion of lactose to glucose and galactose, A116
STINE, J. B., copper and Cheddar flavor, A43
STOKES, D. K., serum alkaline phosphatase activity in cattle, A24
STOKSTAD, E. L. R., antibiotics in animal nutrition, A141
STOLTZ, E. I., antibiotics in milk and human intestinal coliform bacteria, A89
STONE, W. K., influence of lipids on dispersion of milk powder, A133
STORGARDS, T., chromatography of amino acids in cheese, A147; chromatography of volatile acids in cheese, A147
STORHERR, R. W., determination of free gossypol in feeds, A105
STORRS, A. B., enzylac process of modifying milk, A22
STRICKS, W., determination of disulfide groups, A68; titration of sulfhydryl groups, A68
STROBEL, D. R., analysis of flavor research on milk, A97
STRØM, A., multiple sclerosis in Norway, A39
STRUBER, O., correlation between butterfat and protein, A153
STUART, G. H., food product, A116
STÜBER, O., fat-albumin correlation, A31
SUELLENTROP, F. F., apparatus for manufacturing whipped cream, A126
SUESKIND, R. H., frozen pop confection, A88
SUGDEN, B., oligotrich protozoa from sheep's rumen, A116
SUGIHARA, T. F., antibiotic feed supplements, A14
SULLIVAN, J. T., hemicelluloses from orchard grass, A102
SULLIVAN, W., reducing costs of raising calves, A138
SULLIVAN, W. N., effectiveness of lindane vaporizers, A27; lindane toxicity to flies, A78; concentrations and exposure time of lindane vapor required to kill insects, A78; chlorinated polyphenols in improving lindane residues, A155

SUN, J. Y. T., microbioassay of insecticides in milk, A155
SUN, Y-P., microbioassay of insecticides in milk, A155
SUNDARARAJAN, T. A., preparation of dephosphorized casein, A82
SVENDSEN, A. B., amino acids in Gammelost, A115
SWANK, R. I., multiple sclerosis in Norway, A39
SWANSON, A. M., factors affecting nutritive value of milk, A154
SWARTLING, P., chemicals against tin taste in milk, A52; influence of silage quality on milk and cheese quality, A151
SWEERIS, S., cellulase from *Myothecium verrucoria*, A117
SWENSON, H. F., double-headed ice cream freezer, A148
SWINGLE, K. F., experimental tocopherol deficiency in calves, A137
Symposium, boiler water chemistry, A102
SZUMOWSKI, P., pressed vs. extracted linseed cakes as feed, A49

TAKAMINE, H., preservation of bull semen, A26
TALMAGE, R. V., effect of phenothiazine on thyroid uptake of radioiodine, A111
TAMMINGA, W., dispenser for single service milk cans, A153
TANAKA, N., determination of disulfide groups, A68
TARDIFF, R. O., combination package, A87
TASHIRO, H., biological studies of horse flies, A77
TAUCINS, E., carotene and vitamin A in Latvian cattle feed, A34
TAVARES, F., changes produced in milk by adding water, A31
TAYLOR, F. R., fluid milk utilization and disposition, A150
TAYLOR, J. B., cheese slicer, A5
Technical Assistance Mission No. 17 (O.E.E.C.), the cold chain in the U.S.A., A2
TEDFORD, J. R., fluid milk utilization and disposition, A150
TEERI, A. E., limestone lowers silage digestibility, A151
TEICHMAN, R., vitamin A depletion time in calves, A52
TEIXEIRA, F., changes produced in milk by adding water, A31
TERNER, C., glycolysis in lactating mammary gland, A77; synthesis and oxidation of citric acid in mammary homogenates, A128
TESSIER, H., effect of freezing rate on frozen milk stability, A96
THACKLER, E. J., lignin procedure, A102
THOMAS, C. A., filling milk containers, A84; milk release apparatus, A86; milker system, A87; milker apparatus, A107
THOMAS, E. L., keeping quality of pasteurized milk as influenced by psychrophiles and aureomycin, A6
THOMAS, J. W., magnesium determination in bovine blood serum, A102
THOMAS, O. O., carotene and vitamin A metabolism in cattle, A23
THOMAS, R. C., relation of Q-fever to dairy products, A1
THOME, K. E., printing fresh butter, A29; influence of silage quality on milk and cheese quality, A151
THOMPSON, C. R., xanthophylls in alfalfa, A93
THOMPSON, H. J., environmental physiology, A24; A141
THOMPSON, J. B., browning reaction involving copper-proteins, A10
THOMPSON, P. A., antibiotic feed supplements, A14
THOMPSON, W. J., trucks converted to liquefied petroleum gas, A46; liquefied petroleum gas, A72
THOMSEN, T., keeping quality of printed butter, A92
THOMSON, A. M.,, diet and milk yield of ewe, A16
THOMSON, S. Y., nutritive value of colostrum, A25; effect of light on riboflavin in milk, A126
THOMSON, W., diet and milk yield of ewe, A16
THORNTON, H. R., mechanical features of plate type HTST pasteurizer, A97; phosphatase inactivation in HTST pasteurization, A97; creaming impairment in HTST pasteurization, A97
THORSTENSSON-RYDBERG, C. A. S., apparatus for treatment of cream and milk, A148
TIERIE, G., bacteriological requirements for sterilized milk, A8
TIETZ, A., biosynthesis of fatty acids from carboxy-C^{14}-acetate, A39
TILLMAN, A. D., digestibility of prairie hay, A105; metabolism stall for steers, A111
TIMMERSMAN, D. J. W., bulk milk transporting and dispensing apparatus, A122
TITOV, A., enrichment of milk, A23
TKACZYK, S., refractive index of concentrated protein solutions, A102
TOBIAS, J., build a "soft-serve" business, A19
TOBLER, F. R., ultrasonic treatment of milk, A127
TOLBERT, B. M., propionate as precursor of milk constituents, A26
TOLLENAAR, F. D., prevention of cold-storage defect in butter, A3
TOVERUD, S. V., ethylenediamine tetra acetate method for serum calcium, A101
TRACY, P. H., U.S. dairy industry in years ahead, A13; future of soft-frozen desserts, A19; soft served frozen products, A51
TRAISMAN, E., process of making grated cheese, A115
TRAMER, J., reactivation of milk phosphatase, A20; A153
TREBLER, H. A., design of milk-waste disposal plants, A53
TREGILLUS, K. C., valve ring for power washing cream separator, A88
TREGUBOV, V., butter factory waste waters, A28
TREMAZI, A., mineral metabolism in calves, A39
TRIKOJUS, V. M., enzymic iodination of milk proteins, A68
TROUT, G. M., amino acid composition of fat membrane protein, A9; electrophoretic patterns of fat membrane proteins, A9; sedimentation diagrams of fat membrane proteins, A9; half-and-half homogenized milk, A52; testing half-and-half homogenized milks, A70; solar activated flavor of homogenized milk, A126
TSAO, C. H., lindane toxicity to flies, A78
TURNBOW, G. D., preserving fresh flavor of butterfat, A88
TURNER, C. P., centrifugal atomizer, A5
TURNER, D. B., sediment testing apparatus, A22
TURNER, E. L., ice cream package, A125
TURNER, J., effect of water intake on digestibility of hay, A16; effect of concentrate protein on fat content of milk, A137; effect of variations in hay on fat content of milk, A137

ULRICH, H. H., feed from garbage, A16
UMEZU, M., hypoglycemia and insulin ketosis in goats, A26
UNDERKOFLER, L. A., hydrolytic products of cellulose, A93; industrial fermentations, A113
URUSOVA, T. P., possibility of ethylene chloride penetration into milk of mother, A26

VAN ARSDALL, R. N., quality milk at lower costs, A124
VAN DER MOLEN, H., use of whey paste and powder in silage, A14
VAN GENKEL, J. G., method for distinguishing regular and whey butter, A115
VAN HAEFTEN, F. E., cold storage experiments on butter, A143
VAN KOETSVELD, E. E., trimethylamine in fish meal fodders, A49
VENCIA, C., continuous vitamin fortification of milk, A127
VOLCANI, R., orange peels in cattle feeding, A16
VOLOCHKOVA, E., enrichment of sour-milk products, A23
VON GUNTEN, R. L., bulk vs. can for handling milk, A152
VORE, H. G., bottle capping machine, A45
VUOKILA, R., evaluating artificial human milk, A154

WAGNER-JAUREGG, T., action of aliphatic thiocyanate against fly, A27
WALCH, H. A., enhancement of antibiotic production, A8
WALFORD, E. R., isolation of *E. coli* from citrus products, A133
WALKER, L., hereditary female sterility in Holsteins, A124
WALKER, R. W., cream dispensing cabinet, A37
WALKER, S. H., economic analysis of butter-nonfat dry milk plants, A13
WALLENBROCK, R. E., spray-type expansible milk cooler, A107
WALLER, A. G., production and price trends, A149
WALSH, K. A., carotene destruction in alfalfa, A16
WARD, E. H., costs and quality of fluid milk, A85
WARD, G. E., vitamin B_{12} feed supplement, A72
WARD, G. M., mineral metabolism in cows at parturition, A1
WARDEN, L. L., testing cream for extraneous matter, A63
WARNER, R. G., antibiotics in ruminant nutrition, A59
WASHBURN, R. G., relation of mineral contents of milk and pasture herbage, A22
WATROUS, G. H., JR., psychrophilic bacteria in milk, A30
WATSON, J. T., food product, A116
WAUSCHKUHN, B., swelling capacity of proteins during cheese ripening, A115
WAY, R. F., the anatomy of the bovine foot, A91
WAYT, L. K., control of mastitis, A131
WEAVER, K. R., beater mechanism, A20; pumping mechanism, A32
WEAVERS, H. J., butter grading program, A80
WEBSTER, J. R., mechanisms of cutaneous drug reactions, A49
WECKEL, K. G., why advertise dairy products?, A121; continuous vitamin fortification of milk, A127
WEDUM, A. G., ultraviolet irradiation in air conditioner, A101
WEGHER, E. S., homogenized milk in cornstarch puddings, A51; homogenized vs. nonhomogenized milk for foods products, A62
WEIHE, H. D., selectively hydrogenated butter oil, A125
WEIL, C. S., harmlessness of sorbic acid, A57
WEINSTEIN, B. R., half-and-half homogenized milk, A52; solar activated flavor of homogenized milk, A126
WEISBERG, S. M., proteins for latex paints, A80; water paint containing enzyme-digested protein, A145
WEISER, H. H., microbiological factors in treatment of phenolic wastes, A101
WEISS, M. E., ice cream cabinet attachment, A39
WEITS, J., iodinated casein fraction and milk yield of goats, A89
WENTWORTH, W. A., plant experiences with mellorine and ice cream, A19; trends that influence sales, A36
WERTHEIMER, G. P., what's wrong with the cheese industry, A67
WEST, A. C., livestock sprayer, A138
WHITAKER, R., concentrating milk, A30
WHITE, E. G., preventive medicine on the farm, A2
WHITEHAIR, C. K., urea nitrogen in rations containing carbohydrate feeds, A13; carotene and vitamin A metabolism in cattle, A23; placental transfer of vitamin A and carotene by cows, A39
WHITMORE, J., influence of washing and scalding on washed curd cheese, A4
WHITTIER, E. O., system of payment for milk, A32
WHITTLESTONE, W. G., apparatus for drawing milk ejection curves, A38; size distribution of butterfat globules, A69; effect of oxytocin on intramammary pressure, A76; variations in fat content of human milk, A139; effects of vasopressin and acetylcholine on intramammary pressure, A139; effects of oxytocin on intramammary pressure, A139
WICHMANN, H. J., reaction of sodium carbonate and calcium phosphates in ashing milk, A117
WIDDOES, L. C., closure for containers, A70; whipped cream dispenser, A126
WIECHERS, S. G., substitutes for hen albumin from whey, A6
WILDEBOUR, C. W., means for stripping and ribboning ice cream, A76
WILDER, O. H. M., animal fats in feed, A16
WILHIDE, W. D., flame photometric determination of calcium in phosphoric acid, A102
WILKINS, M. H. F., preparation of sperm heads for X-ray diffraction, A25
WILL, L. J., increasing repeat sales of butter, A41
WILLIAMS, L. F., Connecticut mastitis-control program, A1
WILLIAMS, W. F., expectations and plans of milk producers, A71
WILLOUGHBY, D. S., keeping quality of pasteurized milk as influenced by psychrophiles and aureomycin, A6
WILSON, A. T., lactenin: antistreptococcal agent in milk, A10
WILSON, H. G., toxicity of vapors to house flies, A27; baits for control of resistant flies, A155
WILSON, H. L., quality cheese and government standards, A29
WILSON, J. B., test for purity of bromphenol blue, A119

WILSTER, G. H., condensing your mix, A60
WILTBANK, J. N., bactericidal activity of the uterus, A106
WINTERS, L. M., animal breeding, A113
Wisconsin Agr. Expt. Sta., new white cheese, A144; new cheese announced, A144; gas treatment for control of cheese mold, A144; milk resists oxidized flavor, A153
WITZEL, S. A., loose housing or stanchion-type barns, A17
WOLF, B., identity of γ-casein from casein or paracasein, A31
WOLFRUM, O., European dairy plant equipment, A44; trends in European dairy plant equipment, A71
WOLLISH, E. G., colorimetric determination of ascorbic acid, A147
WOLSTENHOLME, G. E. W., mammalian germ cells, A56
WOMACK, M., microbial method of determining protein value, A105
WOOD, F. W., mechanical features of plate type HTST pasteurizer, A97; phosphatase inactivation in HTST pasteurization A97; creaming impairment in HTST pasteurization, A97
WOOD, P. C., nutritive value of colostrum, A25
WOOD, W. A., influence of metabolites on p-aminobenzoate-pantothenate interaction in *B. linens*, A7; nutritional equivalence of pantothenate and p-aminobenzoate for *B. linens*, A7
WOODS, G. M., shedding characteristics and occurrence of mastitis, A1; *M. pyogenes* in milk, A8
WOODS, G. T., individual can and weigh-vat sampling for *Brucella* ring test, A79
WOODWARD, C., method for preparing crystalline rennin, A118; preparing crystalline rennin, A135
WORDEN, A. N., fatal hypocalcaemia-like syndrome in cows, A79
WORK, T. S., amino acid uptake by mammary gland, A77; source of antibody in milk, A127
WORMELL, R. L., process of hardening, esterifying, and rehardening artificial protein threads, A145
WORSTELL, D. M., environmental physiology, A24; A141
WÖSTMANN, B. S. J., whey proteins in bread, A81
WRIGHT, L. D., vitamins in human nutrition, A109
WRIGHT, R. C., reactivation of milk phosphatase, A20; A153
WYLAM, C. B., carbohydrate breakdown during ensilage, A48

YATES, W. W., chemotherapeutic use of insecticides, A27
YOUNG, G. D., controlling flavor and texture in cottage cheese, A4

ZACHARIASSEN, S. H. B., homogenization of liquids, A149
ZAKARIASEN, B. M., greater yields of cottage cheese, A57
ZIELINSKA, M., aroma-producing group "N" streptococci from cheese, A146
ZIEMBA, J. V., Kraft's package lab, A93
ZINZALIAN, G., hard butter composition, A42

ACCOUNTING SYSTEMS, branch, A94
Acetaldehyde, in human milk, A31
Acetate, mammary tissue oxidation of, A128
Acetate, C^{14}, incorporation into lactose by udder, A110
Acetylcholine, effects on intramammary pressure, A139
Acetylcholine metabolism, in spermatozoa, A26
Acid-base balance, of cattle, effects of stresses on, A111
Acid cleaners, ABC's of using, A62
Acid production, substances in herd milks inhibiting, A92
Acidification, in cheese curd, control of, A100
Acidity,
  heat induced, in milk, A134
  titratable, in milk, determination of, A83
Acids,
  component, of whole fat, A118
  unsaturated, in milk fat, A103
Acoustic vibrations, apparatus for production of, A11
Actinomycosis, maggot therapy of, A1
Adrenals, effects of anterior hypophysis on, A26
Adulteration,
  of butter, with vegetable oils, detection of, A134
  of human milk, tests for, A10
  of milk fat, A70
Aerators, for cheese-waste, A155
Aerobacter aerogenes, differentiated from *A. cloacae*, A31
Agriculture, and the people, A71
Albumin,
  in Slovenia fodder, A49
  milk, method for obtaining, A6
  substitutes from whey, A6
Aldehyde values, of fat, determination of, A9
Alfalfa,
  artificially-dehydrated, rate of carotenoid loss in, A15
  factors affecting destruction of carotene in, A16
  Xanthophylls in, A93
Alfalfa ash, effect on digestibility of prairie hay, A105
Alfalfa juice, chick-growth stimulation by, A39
Alfalfa meal, determination of carotene in, A9
Algin, in cacao, detection of, A117
Aliphatic thiocyanates, action against flies, A27
Alkaline cleaners, for HTST pasteurizers, A128
Allethrin, toxicity to flies of methyl and ethyl analogs of, A155
Amino acids,
  content of milk, influence of ration on, A31
  γ casein composition of, A31
  in cheese, chromatography of, A100, A147
  in Gammelost, A115
  lactic acid bacteria biosynthesis of, A101
  mammary gland uptake of, A77
  of crystallized papain, A118
  of fat membrane proteins, A9
  plasma, uptake by perfused udder, A26
  quantitative paper chromatographic determination of, A68, A82
Amino groups, terminal, of α and β caseins, A31
Androgens, in milk, secretion of, A111
Animal protein factor, in feeding animals, A34
Animals, domestic, environmental physiology of, A24
Anterior hypophysis, effects on mammary glands and adrenals, A26
Antibacterial substances, of milk, A127
Antibiotic action, of polyunsaturated fatty acids in sterilized milk, A125
Antibiotic production, enhanced by sea water media, A8
Antibiotic properties, of cheese, A100
Antibiotics,
  as related to cutaneous drug reactions, A49
  effect on utilization of nonprotein nitrogen by rumen organisms, A39
  in animal nutrition, A141
  in feeding animals, A34
  in growth of ruminants, A17
  in milk,
    biological detection of, A22
    effects on coliform bacteria, A89
    in New York, A22
  in nutrition of ruminants, A59
  in raw milk, determination of, A109
  treatment of chronic bloat with, A79
  use of methylene blue milk for assay of, A134
Antibody, in rabbit milk, source of, A127
Antioxidants,
  for butter, testing, A91
  prevention of butter defects with, A3
Apparatus,
  for converting hard frozen confection into plastic state, A51
  for treating liquids, A45
Aralen dihydrochloride, screened against *Anaplasma marginale*, A2
Artificial insemination, semen diluents in, A85
Ascorbic acid, colorimetric determination of, A147
Atomizer, centrifugal, A5
Aureomycin,
  chick-growth stimulation by, A39
  effect on calf growth, A15
  influence on keeping quality of pasteurized milk, A6
Automatic dairies, build new business, A58

BABCOCK BOTTLES, used as pycnometers, A31
Babcock test, of milk from bulk tanks, influence of agitation on, A76
Bacitracin, for calves, A73
Bacteria,
  coliform, effects of antibiotics in milk on, A89
  facultative anaerobic, from sheep's rumen, A67
  lactic acid,
    distribution of types of, A146
    vitamin and amino acid production in associations of, A101
  psychrophilic,
    effect on finished product, A30
    influence on keeping quality of pasteurized milk, A6
  ultraviolet irradiation for removal of, A101
Bactericidal activity, of the uterus, A106
Bactericides, iodine, in dairy industry, A112
Bacteriophage, lactic streptococci,
  desiccated storage of, A8
  role of calcium in proliferation of, A6
Bacteriophage K, staphycoccal, purification of, A117
Bacteriophage multiplication, mechanism of chymotrypsin inhibition of, A116

Bacterium linens,
equivalence of pantothenate and p-aminobenzoate for growth of, A7
p-aminobenzoate-pantothenate interaction in, A7
Barn, milking, portable, A152
Barns, fly control in, A40
Beet molasses, nutritional value of, A49
Belts, conveyor, wire mesh, A70
Benzene vapors, adsorbed by milk, A83
Beverage, powdered lactic acid, A6
Beverages, foamy, A6
Biosynthesis,
of fatty acids from acetate by mammary enzyme system, A39
of milk proteins, A39
Biotin, metabolic functions of, A140
Bloat, chronic, antibiotics for treatment of, A79
Bloating sickness, carbohydrate nutrition in, A29
Blood serum, determination of magnesium in, A102
Blood volume, of cows, A26
Body surface, water evaporation from, A110
Body temperature, of cattle, effect of management systems on, A35
Boiler water, symposium on chemistry of, A102
Book reviews,
Advances in Enzymology, vol. 15, A99
Air Conditioning-Refrigerating Data Book, Design vol., 8th ed., A41
Animal Breeding, A113
Antiseptics, Disinfectants, Fungicides, Chemical and Physical Sterilization, A65
Artificial Breeding and Livestock Improvement, A114
Biochemistry and Physiology of Nutrition, vol. I, A2
Biochemistry and Physiology of Nutrition, vol. II, A91
Industrial Fermentations, A113
Industrial Wastes, Their Disposal and Treatment, A3
Laboratory Instruments. Their Design and Application, A99
Livestock Production, A131
Mammalian Germ Cells, A56
Manual of Infertility and Artificial Insemination of Cattle, A41
Principles of Crop Husbandry in India, A79
Principles of Veterinary Science, 5th ed., A66
Pumps, A41
The Anatomy of the Bovine Foot, A91
The Cold Chain in the U.S.A., A2
Bottle capping machine, A45
Bottle carrier, A85
Bottle carrying pocket, A28
Bottle filler valve, A103
Branch accounting systems, A94
Bread, whey proteins in, A81
Breeds, of dairy cattle, A152
Brine tank elevator, A11
Bromates, in milk, determination of, A148
Bromphenol blue, test for purity of, A119
Browning, of milk, heat induced, A134
Browning reaction, involving copper-proteins, A10
Brucella immunity, new studies on, A131
Brucella melitensis, nutrition of, A31
Brucella ring test, individual can vs. weigh-vat sampling for, A79
Brucellosis, extermination of, A99
Bucket, calf, nipple for, A74
Bulk dispensers, milk sales with, A32
Bulk milk handling, A51, A122, A138
Bulk tanks,
conversion to, A122
influence of agitation on Babcock test of milk from, A76
sediment testing milk in, A88
Butter,
adulterated with vegetable oils, detection of, A134
Argentine, characteristics of, A42
aromatic, manufacture of, A80
cold-storage experiments on, A143
detection of fish fats in, A42
detection of margarine in, A42
effect of temperature treatment of cream on consistency of, A132
electrical resistance and keeping qualities of, A131
flavor counts, A99
fresh, printing of, A29
graded, production in Switzerland, A3
hard, composition, A42
in cheese dairies, oxidation phenomena of, A143
increasing repeat sales of, A41
influence of tocopherol feeding on tocopherol content and keeping quality of, A33
malty defect of, A151
manufacturing costs per pound of, A136
method of distinguishing between whey butter and, A115
non-washed, quality and keeping quality of, A42
prevention of cold-storage defects in, A3
printed, keeping quality of, A92
problem of fishiness in, A132
rapid estimation of WIA in, A119
stability of vitamin A and carotene in, A154
storage changes in diacetyl, acetoin, and plate counts of, A143
testing antioxidants for, A91
the future of, A3
transformation of gas phase in, A3
Butter analysis, new index for, A42
Butter cartons, new look in, A136
Butter cultures, intensification of aroma of, A3
Butter cutting machine, A103
Butter factories, waste water from, A28
Butter-formation process, role of surface phenomena in, A42
Butter grading, Wisconsin's program of, A80
Butter print mold, A143
Butter server, individual, automatic, A29
Butter starter, comments on, A92
Butterfat,
correlation between protein and, A153
detection of hydrogenated oil in, A10
globules, size distribution of, A69
in milk,
comparison of Schain and Babcock tests for, A117
"SAL" procedure for determination of, A103
New Zealand, seasonal variation of fatty acids in, A69
process for preserving flavor of, A88
research, the field of, A119
synthesis, mechanism of, A39
tests, affected by roughage supply, A33
Buttermaking, continuous process, A4
Buttermilk, good, A67
Butters, Indian, vitamin D in, A132

CACAO PRODUCTS, detection of algin and gums in, A117
Calcium,
effect on bacteriophage proliferation, A6
effects of intravenous administration of, A24
in phosphoric acid, flame photometric determination of, A102
lactate and glycerolphosphate, therapeutic solution of, A2
metabolism, physiology of, A24
serum, ethylenediamine tetra acetate method for, A101
Calf, nutritive value of colostrum for, A25
Calf puller, A152
Calf table, reversible, A86
Calf weaning halter, A86
Calves,
antibotic studies with, A73
development and survival, A17, A74, A124
effect of aureomycin on growth of, A15
effects of intravenous injection of salts on, A24
estimation of vitamin A depletion time in, A52
experimental tocopherol deficiency in, A137
factors involved in forage quality for, A137
glycemic levels and rumen development in, A39
mineral metabolism of, A39
oil-based insecticide carrier as cause of hyperkeratosis in, A55
relationship of vitamin A to hyperkeratosis in, A55
thrive in portable pens, A2
Can,
holder and puncturing device, A30
washing and liquid feeding device, A149
washing and sterilizing process, A149
Capillary walls, passage of molecules through, A25
Carbohydrate breakdown, during wilting and ensilage, A48
Carbohydrate nutrition, in bloating sickness, A29
Carbohydrates, dietary, utilization by ruminants, A16
Carob, nutritive value of, A49
Carotene,
factors affecting destruction in alfalfa, A16
feed content of, A34
in alfalfa meal, A9
in butter, stability of, A154
metabolism in cattle and sheep, A23
placental and mammary transfer of, A39
Carotenoid loss, in dehydrated alfalfa, rate of, A15
Carotenoids,
calf liver stores of, A23
in milk,
effect of mastitis on, A113
throughout lactation, A69
Carrageenins, effect on viscosity of milk, A97
Carrier, for milk cartons, A104
Case-handling, modern, A94
Casein,
chick-growth stimulation by, A39
dephosphorized, enzymatic preparation of, A82
hydrolysis of, A31
iodinated,
effect on milk yield, A89
effects upon cattle, A34
lactic, stabilized solution of, A5
purified, for nutritional research, A140
stability in frozen milk, A10
synthesis, mammary use of glutamine for, A154
Casein, α, phosphorus linkages in, A147
Casein, α and β, terminal amino groups of, A31
Casein, γ,
amino acids composition of, A31
isloated from casein or paracasein, A31
Cathode rays, and the dairy industry, A9
Cattle,
dairy, productive life-span of, A124
effects of grades of hay and cod-liver oil on, A14
effects of iodinated casein and L-thyroxine feeding on, A34
factors affecting reproductive efficiency of, A106
grazing, measurement of feed intake by, A49
Holstein-Friesian, streaked hairlessness in, A59
loose housing vs. stanchion barns for, A17
minerals for, A123
pure and crossbred, serum alkaline phosphatase activity in, A24
suitability and utilization of winter forages for, A34
twin,
description of variation in, A34
monozygotic, studies in, A49, A50
variation of fertility in, A35
Cattle diseases, copper and molybdenum in relation to, A2
Cattle teeth, anatomy and physiology of, A131
Cells, in milk, A65
Cellulase, from *Myrothecium verrucaria*, properties of, A117
Cellulose, ruminant digestion of, A123
Cellulose digestion,
by rumen microorganisms, A93
unidentified factor stimulatory to, A13
Cheddar flavor, and copper, A43
Cheese,
and cheese wrapper, determination of sorbic acid in, A57
and process of, A29
antibiotic properties of, A100
bitter compounds of, A143
Cheddar,
curing, moisture losses in, A132
inhibition and stimulation of streptococci used in, A145
manufacturing cost in New York, A80
ripening in, A4
tyramine in relation to flavor of, A4
cottage,
and cream, tested for starting material pasteurization, A43
controlling flavor and texture of, A4
greater yields of, A57
keeping quality of, A92
sanitary production of, A43
with raisins, A42
cream type, made from condensed cream, A80
cultivation of anaerobic spore-formers from, A146
dehydroacetic acid in, A115
development of "bank"-red in, A30
Dutch, salt distribution in, A5
Edam, factors influencing ripening of, A144
elimination of bitter defect of, A5
Emmenthaler, effect of oxidizing salts on ripening of, A144
factors influencing grade of, A67
gas treatment for, A144
grated, process for, A115
manufacture of, A4
methods for packaging and treatment of, A133
migration of sorbic acid from wrapper into, A57
new, is announced, A144
new white, good for cooking, A144

paper chromatography of amino acids in, A100, A147
paper chromatography of volatile acids in, A147
production of, A33
protection, effectiveness of sorbic acid in, A57
quality, A29
resistance of sorbic acid to oxidative deterioration in, A57
ripening, open texture or late gas defect in, A30
soft,
determination of fat in, A43
manufactured in all-metal plant, A5
Stilton, surface microflora of, A147
Swiss, grass silage and quality of, A66
washed curd variety of, A4
yield and recovery numbers of Jersey and Red Danish milk made into, A144
Cheese compositions, liquid, A144
Cheese costs, modernizing cuts, A58
Cheese curd,
Cheddar, aroma-producing group N streptococci from, A146
control of acidification, A100
marketing, A145
moisture-retaining capacity of, A115
Cheese curd cutter, A29
Cheese handling, simplified by engineered press, A4
Cheese industry,
1900-1951, patent developments in, A66
what's wrong with the, A67
Cheese maker, mechanical, A92
Cheese making, modernized procedures in, A42
Cheese making process, A5
Cheese mites, chemical control of, A66
Cheese packaging, A115
Cheese production, sanitary aspects of, A42
Cheese quality, effect of silage quality on, A151
Cheese salt, new, A100
Cheese slice treatment, A133
Cheese slicer, A5
Cheese-waste, aerators for, A155
Cheeses, vitamin B_2 content of, A43
Chemical processes, modern, A115
Chick-growth, stimulation by aureomycin, casein, and alfalfa juice, A39
Chlorides, in milk, determination of, A44
Chlorides: lactose in milk, relationship of, A31
Chlorinated hydrocarbon insecticides, toxicity of vapors of, A27
Chlorinated polyphenyls, for lindane residues, A155
Chromatography, paper,
for amino acids in cheese, use of, A100
monodimensional, quantitative determination of amino acids by, A68, A82
of amino acids in cheese, A147
of volatile acids in cheese, A147
Churn, A80
Churning, in absence of foam, A143
Chymotrypsin, inhibition of bacteriophage multiplication by, A116
Citric acid,
enzymic estimation of, A118
in mammary homogenates, synthesis and oxidation of, A128
Citrovorum factor, synthesis by *L. citrovorum*, A31
Citrus-flavored sherbets, A51
Citrus peel, low-methoxyl pectin production from, A19
Cleaners,
acid, ABC's of using, A62
alkaline, for HTST pasteurizers, A128
Cleaning, comparative, of diphase and emulsion systems, A53
Cleaning efficiency, of detergents, methods for assessing, A40
Cleaning, in-place,
economics of, A52
of glass lines, A40
of pasteurizing equipment, A77
Clover, used by dairymen to cut costs, A48
Coating apparatus, for ice cream in cones, A153
Coating chocolate bars, A50
Coating composition, for frozen confection, A87
Cobalt salts, in feeding cattle, use of, A34
Cod-liver oil, fed with grades of hay to cattle, effects of, A14
Cold milk separation, A126
Cold storage plant, design, A11
Coliform, in ice cream, A96
Coliform bacteria, effects of antibiotics in milk on, A89
Coliform counts, A43
Colostrum,
absorption of immune globulin after ingestion of, A40
bovine and human, electrophoretic studies of, A40
nutritive value of, A25
Combination package, A87
Concentrated milk, new market for, A67
Concentrates,
frozen citrus, A60
with different fat content for cows, A33
Condensed mix, A60
Coniferous tree needles, as vitamin rich food for cattle, A34
Consumer satisfaction, from packaged ice cream, A36
Consumers, of ice cream, keeping loyalty of, A37
Container,
dairy, sediment trap for, A22
for dispensing liquids, A81
for frozen products, A125
half-gallon, saving by standardization of, A37
milk can, A5
Container structure, A148
Containers,
apparatus and method of filling, A70, A75, A84
closure for, A70
paper vs. glass, A84
plastic, for dairy products, A136
Cooler,
milk, portable, A138
tank, milk, A151
Cooler door, pneumatic, automatic, A136
Coolers, milk, surface, efficiencies of, A138
Copper,
and Cheddar flavor, A43
deficiency, in ruminants, A25
diseases of cattle in relation to, A2
in dried milk, estimation of, A102
Copper-proteins, a browning reaction involving, A10
Corn syrup, used in orange flavor formula, A60
Cornstarch puddings, effect of homogenized milk on viscosity of, A51
Corpus luteum, of pregnancy, essentiality of, A25

Costs,
cut by bending pipe, A32
dairy, reduced by high quality roughage, A106
ice cream, trends in, A37
lower, selling more at, A45
marketing, A122
operating, reduction of, A104
Cottonseed, whole, in dairy rations, A73
Counts,
bacteria, of refrigerated milk, A82
bacterial, significance of representative fields of milk films for, A116
coliform and standard, A43
coliform and standard plate, on frozen desserts, A37
plate, on milk, new media for, A100
Cow,
plasma and blood volumes in the, A26
sympathomimetic activity of organ extracts of, A26
urine, methods of studying, A39
Cows,
blood mineral constituents of, A26
pure and crossbred, relation of surface area to heat tolerance in, A24
trials with low and high fat rations for, A123
Cream,
apparatus for treatment of, A148
condensed, cream-type cheese from, A80
device for churning small quantities of, A131
equipment for testing for extraneous matter in, A63
frozen, how to limit oxidation in, A62
rapid estimation of WIA in, A88, A119
used in ice cream,
standards for, A107
State regulations for, A108
viscosity of, A51
whipped,
apparatus for, A126
Cream dispensing cabinet, refrigerated, A37
Cream production, in Ohio, shifts in, A136
Cream quality, standards for, A76
Cream separator, power washing, A119
Creaming impairment, by HTST pasteurization, A97
Credit unions, company, A71
Crops, ensiled, addition of "Kofa" salt to, A16
Cultured milks, A43
Curd mill, A145
Cutter, for cheese curd, A29
Cystine, determination of disulfide groups in, A68

DAIRIES, automatic, build new business, A58
Dairy cattle breeds, A152
Dairy chocolate, sell to restaurants, A33
Dairy equipment, aluminum, water corrosion of, A18
Dairy farmer, the challenge to, A58
Dairy farms,
costs and returns on, A18
hired workers on, A18
Dairy industry,
annual study of trends in, A60
cathode rays and, A9
engineering needs of, A104
Florida, trends of, A104
future trends in, A47
problem of waste water in, A128
U. S., and the years ahead, A13
Dairy paints, application of, A46
Dairy plant,
European, equipment trends in, A44, A71
future, A149
labor, A149
sanitation, A98
Dairy plants,
experiences with mellorine and ice cream, A19
use of jet cleaners in, A53
Dairy product and process, A89
Dairy production, in New Jersey, A149
Dairy products,
advertisement of, A121
detection of substitute fats in, A44
dietetic sour, continuous process for, A52
for military subsistence, A13
identification of gums in, A83
manufactured, 1951 production, A13
plastic containers for, A136
Q-fever and its relation to, A1
sampling dipper for, A45
selling consumers on nutritional value of, A23
selling farmers, A72
special, research on, A59
what people think of, A122
who buys and why, A150
Dairy program, development of, A12
Dairy science,
reviews of progress in,
chemistry and physical chemistry, rheology and general physics, A68
nutritive value of milk and milk products, A140
Dairy units, maple syrup process in, A104
Dairy wastes, aerobic treatment of, A26
Defrosting low temperature evaporators, A135
Dehorning tool, A18
Dehydroacetic acid, in cheese, A115
Desiccating apparatus, A84
Detergent activity, effect of hypochlorite on, A112
Detergent solutions, adhesion to different materials, A112
Detergents,
and milk tests, A10
assessing cleaning efficiency of, A40
DHIA program, A17
Diabetics, low carbohydrate ice cream for, A74, A87
Digestion, ruminant, A25, A26
Dilator, for clogged teats, A29
Dipper, sampling, for dairy products, A45
Dispenser,
feed, self-dumping, A138
for single service milk cans, A153
whipped cream, A126
Dispensers, in Ft. Smith, A120
Dispensing cabinet, cream, refrigerated, A37
Disposal plants, small, for milk-waste, design of, A53
Disulfide groups, polarographic and amperometric determination of, A68
Door control, vacuum actuated, A74
Drinking bowl, animal operated, A35
Drug reactions, cutaneous, mechanisms of, A49
Dry matter intake, indicators in measurement of, A14

EATING UTENSILS, adherence of organisms and soil to, A63
Economics, of in-place cleaning, A52
Electrolyte metabolism, A141

Electrophoretic patterns, of fat-membrane proteins, A9
Electrophoretic studies, of colostrum, A40
Employee grievances, how to handle, A151
Energy, of milk, estimated from fat and total solids, A69
Ensilage, carbohydrate breakdown during, A48
Environmental physiology, and shelter engineering, A141
Enzylac process, of modifying milk, A22
Ergothioneine, sulfur and formation of, A39
Escherichia coli,
and *S. faecalis*, in relation to sanitary quality of food, A133
boric acid and lactose broths for isolation of, A133
Estrogens,
in milk, secretion of, A111
of semen, investigation of, A25
Ethylene chloride, possibility of penetration into milk of nursing mother, A26
Ethylenediamine tetra acetate method, for serum calcium, A101
Ethylvanillin extract, detection of, A118
Evaporative cooling, A10
Evaporators, low temperature, defrosting, A135
Ewell plan, brought up to date, A46
Expansion, sound financing for, A71
Extraneous matter, in cream, testing equipment for, A63

FALLOPIAN TUBES, disease conditions in, A79
Farm, preventive medicine on the, A2
Farm products, analysis of demand for, A17
Farm record summary, in S. Dakota, A87
Farmers, selling dairy products to, A72
Fat,
in milk products, uniform method for determination of, A117
in soft cheese, determination of, A43
milk, unsaturated acids in, A103
nutritive values of, A76
photoelectric determination of aldehyde values of, A9
Fat-albumin correlation, A31
Fat content, of human milk, variations in, A139
Fat contents, different, in concentrates for cows, A33
Fat globules, size distribution in cream and butter, A20
Fat-membrane proteins,
amino acids of, A9
electrophoretic patterns of, A9
sedimentation diagrams of, A9
Fat percentage, causes of variations in, A86
Fat rancidity, mechanism of, A44
Fat test, of milk, in Saratov region, A10
Fats,
animal, added to feed, A16
foreign, developing tests for, A148
stabilized, effect on vitamin A stability in, A59
substitute, in dairy products, detection of, A44
Fattening, hormonal, mechanism of, A39
Fatty acids,
α, β-unsaturated, metabolism of, A57
biosynthesis from acetate by mammary enzyme system, A39
in New Zealand butterfat, seasonal variations of, A69
polyunsaturated, in sterilized milk, antibiotic action of, A125
Fecal nitrogen, metabolic, determination of, A110
Feed,
animal,
high protein, A16
made out of garbage, A16
cattle,
carotene and vitamin A contents of, A34
Ischaemum rugosum as, A34
Themeda quadrivalvis as, A16
Feed dispenser, self-dumping, A138
Feed energy, TDN as measure of, A14
Feed formulas, adding animal fat to, A16
Feed intake, by grazing animals, measurement of, A49
Feed roller attachment, for butter print machinery, A148
Feed supplement, vitamin B_{12}, A72
Feeder,
dairy, mechanical, A106
livestock, A36
Feeding systems, winter, compared, A73
Feeds, animal,
analyses of, A16
effect of stabilized fats on vitamin A stability in, A59
Feeds, carbohydrate, value of urea nitrogen in rations containing, A13
Feeds, mixed, determination of gossypol in, A105
Fermented milks, A43
Fertility, in twin cattle, variation in, A35
Field developments, new ideas from, A27
Filler, ice cream, automatic, A37
Financing, sound, for expansion, A71
Fish fats, in butter, detection of, A42
Fish meal, trimethylamine in fodders containing, A49
Fishiness, in butter, problem of, A132
Flavor injection unit, for frozen dessert machines, A51
Flavor research, on milk, analysis of, A97
Flavor scoreboard, A95
Flies,
horse, biological studies of, A77
house, toxicity of lindanes for, A78
resistant, baits for control of, A155
toxicity of methyl and ethyl analogs of allethrin to, A155
Fluorine, controlled feeding of, A105
Fly, DDT-resistant, action of aliphatic thiocyanates against, A27
Fly control, in barns, A40
Fly repellent tests, A154
Fly repellents, new, A154
Fodder,
determination of vitamin E in, A31
dried, green, effect on sperm quality, A106
from gourds, A49
Slovenia, albumin in, A49
yucca leaves as, A48
Fodders, containing fish meal, trimethylamine in, A49
Food,
determination of vitamin E in, A31
E. coli and *S. faecalis* as test organisms for determining sanitary quality of, A133
infant, A6
vitamin rich, for animals, needles of coniferous trees as, A34
Food brokers, use of, A12
Food delivery box, A48

Food product, A116
for animals, A106
milk protein, A30
Food product flavoring, composition and preparation of, A67
Food products, milk in preparation of, A62
Foods, radiation sterilization of, A101
Forage, digestibility and intake, as related to milk production, A48
Forage grasses, in N.E. States, diseases of, A106
Forage quality, factors involved in, A137
Forages,
harvesting and preserving, A17
winter, suitability and utilization by cattle, A34
Foreign fats, developing tests for, A148
Formula, orange flavor, use of corn syrup in, A60
Fountains, in super-markets, A50
Freezer converter, A148
Friesian milk, composition of, A83
Frozen comestibles, merchandising machine for, A76
Frozen concentrated milk products, A43
Frozen confection,
apparatus for completing and packaging, A70
coating composition for, A87
mold, A124
sandwich container, A107
Frozen confections,
machine for manufacture of, A87
refrigerator apparatus for, A70
stick, past-present-future, A18
Frozen cream, how to limit oxidation in, A62
Frozen dessert, vegetable fat, Costello's volume of, A50
Frozen dessert business, soft, quality key to success in, A62
Frozen dessert machines, flavor injection unit for, A51
Frozen desserts,
base materials for, A19, A108
coliform and standard plate counts on, A37
soft, future of, A19
1953 sales index of, A153
use of sucaryl in, A61
Frozen milk,
effect of freezing rate on stability of, A96
estimation of protein denaturation in, A97
Frozen milks, recombined, prevention of oxidized flavor in, A125
Frozen pop confection, A88
Frozen products,
container for, A125
soft served, A51
Fruit concentrates, frozen, A60

GALEGA *officinalis*, a poisonous plant for ruminants, A26
Gammelost, amino acids in, A115
Garbage, Omaha makes feed out of, A16
Genus *Bacillus*, as source of growth stimulants, A14
Germicides, quaternary ammonium, testing, A31
Glass lines, cleaning in place, A40
Glass piping, industrial, A77
Glucose, mammary tissue oxidation of, A128
Glutamine, used for mammary synthesis of casein, A154
Glutathione, oxidized, determination of disulfide groups in, A68
Glycemic levels, in calves, and rumen development, A39
Glycerol, in sheep rumen, fermentation of, A48
Glycolysis, in lactating mammary gland, A77
Gossypol, in feeds, determination of, A105
Gourds, edible oil and fodder from, A49
Grain, course or fine?, A73
Grass, artificially dried, A49
Grasses, forage, in N.E. States, diseases of, A106
Grazing behavior, as related to milk production, A48
Growth stimulants, genus *Bacillus* as source of, A14
Grubs, on cattle, destruction of, A151
Gums,
in cacao, detection of, A117
in dairy products, identification of, A83
Gutter cleaner,
barn, A86
for cow barns, A50

HAY,
effect of water intake on digestibility and passage of, A16
Lucerne, digestibility of, A16
prairie, effect of alfalfa ash on digestibility of, A105
variations in, as affecting secretion of low-fat milk, A137
Heat exchanger,
plate, A11
plate type, A84
Heat tolerance, in cattle, relationship of surface area to, A24
Heat tolerance test, repeatability of, A24
Heat treatment, high, of milk, A76
Heating, induction and dielectric, A115
Heifer replacements, reducing costs of, A138
Helichrysum italicum, effect on vitamin C in sheep milk, A26
Hemicelluloses, from orchard grasses, isolation of, A102
Hexokinase, of *P. putrefaciens*, A31
Hexosamine, in milk, A10
Holding room, sub-zero, on wheels, A94
Holstein-Friesian cattle, hereditary female sterility in, A124
Homogenization, of liquids, method for, A149
Homogenizer capacity, increasing, A51
Homogenizers, HTST timing with, A31
Homogenizing device, for liquids, A84
Hormonal fattening, sterilization, and lactation, mechanism of, A39
Hormonal mechanism, of mammary development and lactation, A26
Hyaluronidase activity, in preservation of semen, A26
Hyaluronidase, testicular, characteristics of, A39
Hydrogenated oil, as adulterant of butterfat, detection of, A10
Hyperkeratosis, in calves,
produced by oil-based insecticide carrier, A55
relationship of vitamin A to, A55
Hypocalcaemia, fatal, associated with excess consumption of fodder-beet, A79
Hypochlorite, effect on detergent activity, A112

ICE CREAM,
bar, bagging machine for, A20
bars, chocolate coated, A75
beater mechanism for softening of, A20
bulk,
pre-dipping, A125
pre-dipping for greater sales, A108

cabinet attachment, A139
coliform in, A96
compositions, stabilized, A37
compounds affecting dryness of, A59
cone vending machine, A152, A87
consumers, keeping loyalty of, A37
costs, trends in, A37
efficient packaging cuts marketing costs of, A96
experiences of plants with mellorine and, A19
filler, automatic, A37
flavor, vanilla-like synthetic cuts cost of, A60
freezer, double headed, A148
1953 gallonage, A75
in cones, coating apparatus for, A153
in foreign lands, A50
industry, engineering needs of, A104
low carbohydrate, for diabetics, A74, A87
making plate, A152
means for striping and ribboning of, A76
mix,
HTST pasteurization of, A18
made by condensing, A60
multiflavor, nozzle for, A87
new flavor of, A75
package, A125
packaged, consumer satisfaction from, A36
packages, size analysis of, A125
packaging machine, A103
parlor, floating, A152
plant, Borden's newest, A50
plants,
corrosion of stainless steel in, A111
time and motion studies in, A87
pre-dipped bulk, self-service sales of, A125
process control for, A75
sales influencing trends, A36
sandwich wafers, production apparatus for, A87
scoop, A51
slicer, A19
standards for cream used in, A107
state regulations for cream used in, A108
stencils, individuality in, A61
stick dispensing machine, A20
sundaes, method for, A153
super-market survey on, A19
tarts, forming head for, A20
tubs, stabilizing device for, A139
variegated,
apparatus for, A75
method for, A152
what consumer likes in, A61
Immune globulin, absorption by lamb after ingestion of colostrum, A40
Indicators, in measurement of dry matter intake, use of, A14
Infant food, A6
Inflation, for milkers, A74
Inflations, resilient, device for reversing, A74
Insecticide applicator, A53
Insecticide carrier, oil-based, hyperkeratosis in calves caused by, A55
Insecticides,
chemotherapeutic use of, A27
chlorinated hydrocarbon, toxicity of vapors of, A27
in foods, problems of, A111
in milk, bioassay of, A155
Insects, bloodsucking, chemotherapeutic use of insecticides against, A27
Insulin, concepts of action of, A141
Intramammary pressure,
effect of oxytocin on, A76, A139
effects of vasopressin and acetylcholine on, A139
recording tympanometer for measurement of, A139
Iodinated casein, effect on milk yield, A89
Iodination, enzymic, of milk proteins, A68
Iodine bactericides, in dairy industry, A112
Iodine, content in milk, A10
Iodophors, as sanitizing agents, A98
Ionic concentrations, in milk, variations of, A10, A127
Ischaemum rugosum, as a cattle feed, A34

JET CLEANERS, use in dairy plants, A53

KETOSIS, in goats, A26
"Kofa" salt, addition to ensiled crops, A16
Kuwazu disease, biochemical studies on, A2

LABOR,
dairy plant, A149
pumping curd saves, A4
requirements, dairy, A74
Laboratory services, expansion of, A94
Lactation,
biochemistry of, A39
hormonal mechanism of, A26, A39
late, effects of once-daily milking in, A138
stage, physical properties of milk influenced by, A69
Lacteal fluids, method of drying, A5
Lactenin, in milk, A10
Lactic acid bacteria,
distribution of types of, A146
vitamin and amino acid production in associations of, A101
Lactobacilli,
classification of, A6
from calf rumen, studies of, A145
Lactose: chlorides in milk, relationship of, A31
Lactose,
conversion to glucose and galactose, A116
in milk, variations in concentrations of, A10, A127
synthesis, from glucose in mammary gland, A128
Legumes,
in Louisiana, experiments with, A105
in N.E. states, diseases of, A106
vitamin content of, A49
Leuconostoc citrovorum, synthesis of citrovorum factor by, A31
Lignin, modified procedure for, A102
Limestone, effect on silage digestibility, A151
Lindane,
evaporation rate and toxicity to flies of, A77
residues, chlorinated polyphenyls for, A155
vapor, concentration and time required to kill insects, A78
vaporizers, effectiveness of, A27
Linseed cakes, for milk production, A49
Linseed oil meal, expeller vs. solvent process for milking cows, A15
Lipids, effect on dispersion of milk powder, A133
Lipoic acid, metabolic functions of, A140
Liquefied petroleum gas, A72
trucks converted to, A46
Lithographic plate coating, composition for, A145
Live weight, influence on milk production, A73
Liver stores, calf, of carotenoids and vitamin A, estimation of, A23

Livestock feeder, A36
Livestock sprayer, A138
Lucerne, artificially dried, A49

MACHINE, for inserting containers, A148
Machine milking,
abnormal, effects on histopathology of udders, A56
variations in rate of, A38
Maggot therapy, of actinomycosis, A1
Magnesium,
effects of intravenous administration of, A24
in blood serum, determination of, A102
Maintenance repair, saving on, A58
Mammary development, hormonal mechanism of, A26
Mammary gland,
effects of anterior hypophysis on, A26
lactating, glycolysis in, A77
synthesis of lactose from glucose in, A128
uptake of amino acids by, A77
use of glutamine for casein synthesis by, A154
Mammary gland homogenates, synthesis and oxidation of citric acid in, A128
Mammary homogenates, biosynthesis of fatty acids from acetate by, A39
Mammary tissue, lactating, oxidation of glucose and acetate by, A128
Management systems, effect on milk yield and body temperature, A35
Manure conveyor, reciprocating hoe type, A86
Maple syrup process, in dairy units, A104
Margarine,
effect on mouse reproduction, A23
in butter, detection of, A42
Marketing cheese curd, A145
Marketing costs, A122
Mastitis,
control of, A1, A131
relationship between method of stripping and, A65
Mastitis milk, carotenoids, vitamin A and phosphorus in, A113
Media, new, for milk plate counts, A100
Mellorine,
experiences of plants with ice cream and, A19
1953 volume in, A153
Menadione, effect on rate of milk souring, A52, A108
Merchandising machine, for frozen comestibles, A76
Metabolic functions, A140
Metabolism,
calcium, physiology of, A24
carotene and vitamin A, of phosphorus deficient cattle, A23
mineral, of calves, A39
of acetylcholine in spermatozoa, A26
of sorbic acid, A57
water and electrolyte, A141
Metabolism stall, for steers, A111
Methyl red test, in peptone media, A68
Methylene blue milk, assay of antibiotics by use of, A134
Methylene blue stain, methods for preparation and use of, A100
Methylene blue test, effect of addition of rennet to, A88
Microbial fermentation, in bovine rumen, magnitude of, A136
Micrococci, action of hypochlorite on, A8
Micrococcus pyogenes, in milk, A1, A8
Microflora, surface, of Stilton cheese, A147
Microorganisms,
rumen,
cellulose digestion by, A93
protein synthesis by, A7
two fractions from raw milk inhibitory for, A145
Mildew, eliminated by new paint, A46
Milk,
adsorption of benzene vapors by, A83
analysis of flavor research on, A97
and milk fat yield, relation between blood minerals and, A25
and milk products,
laboratory for improvement in quality of, A52
nutritive value of, A140
antibacterial substances of, A127
apparatus for treatment of, A148
as semen diluter, A73
bioassay of insecticides in, A155
biochemistry of phosphorus in, A39
biological detection of antibiotics in, A22
biological detection of preservatives in, A147
bottled, production of, A33
bulk, transporting and dispensing apparatus for, A122
cells in, A65
chemical and physico-chemical properties of, A21
chemicals against tin taste in, A52
concentrated, new market for, A67
concentration process for, A30
condensed, causing grey discoloration of coffee, A109
continuously sterilized, properties of, A154
cow and buffalo, solids-not-fat in, A89
creaming impairment in HTST pasteurization of, A97
detection of preservatives in, A82
determination of chlorides in, A44
determination of titratable acidity of, A83
dried,
dispersion and stability of, A6
estimation of copper in, A102
whole, antioxygenic action of vitamin C on, A6
effect of carrageenins on viscosity of, A97
effect of nebacetin in, A81
effect of water or urine on physical constants of, A31
enrichment with vitamin D, A23
factors affecting nutritive value of, A154
fat test of, A10
fluid,
effect of calcium removal on properties of, A135
grade, supply and utilization in Mississippi, A84
in Utah and Montana, costs, quality, and prices of, A85
New York, antibiotics in, A22
supermarket survey on, A103
utilization and disposition in Rhode Island, A150
fortified, control of vitamin D in, A23
Friesian, composition of, A83
from bulk tanks, influence of agitation on Babcock test of, A76
frozen,
casein stability in, A10
effect of freezing rate on stability of, A96

estimation of protein denaturation in, A97
goat, detection of cow milk in, A126
heat-induced acidity in, A134
heat-induced browning of, A134
hexosamine in, A10
high heat treatment of, A76
homogenized,
effect on viscosity of corn starch puddings, A51
half and half, A52
increasing homogenizer capacity for, A51
in preparation of foods, use of, A62
solar activated flavor of, A126
human,
artificial, rat as test animal for evaluation of, A154
chemical composition of, A10
nicotinic acid in, A31
pyruvic acid and acetaldehyde in, A31
tests for adulteration of, A10
variations in fat content of, A139
identification of *M. pyogenes* in, A8
influence of feeding silage on properties of, A14
influence of ration on amino acid composition of, A31
inoculated, summer and winter rates of deterioration of, A134
in paper containers, outer-market distribution of, A150
in the cow, vitamin enrichment of, A23
iodine content of, A10
ionic and lactose concentrations in, A10
kangaroo, composition of, A31
lactenin in, A10
low-fat,
effect of protein content of concentrates on secretion of, A137
effect of variations in hay on secretion of, A137
M. pyogenes in, A1
malty defect of, A151
media for plate counts on, A100
methods for determination of phosphatase in, A10
nonfat dry, greater sales of, A81
nutritive value for rats, A23
of African women, protein content of, A10
origin of sunlight flavor in, A37
partition of carotenoids and vitamin A in, A69
pasteurized,
bacteriological studies on, A7
cold milk separation of, A20
cost of, A84
influence of psychrophiles and aureomycin on keeping quality of, A6
phosphatase inactivation in HTST pasteurization of, A97
physical properties of, A69
pricing fat and skim components of, A71
protein reducing value of, A9
quality, at lower costs, A124
quantity and quality, from different quarters of udder, A89
rabbit, source of antibody in, A127
raw,
determination of antibiotics in, A109
inhibition of microorganisms by, A145
reaction of salts during ashing of, A117
reconstituted,
in normal milk, colorimetric determination of, A117
process for, A22
refrigerated, factors affecting plate counts of, A82
relationship of lactose to chlorides in, A31
resistant to oxidized flavor, A153
ropy,
biology of rope production, A81
chemical studies of ropy substance, A81
"SAL" procedure for determining butterfat content of, A103
sheep, effect of *Helichrysum italicum* on vitamin C content of, A26
skim,
fluid, market for, A85
powdered, improving ease of reconstitution of, A92
reconstituted, temperature variation of specific gravity of, A133
sow's,
composition throughout lactation, A69
estimation of energy of, A69
sterilized,
antibiotic action of polyunsaturated fatty acids in, A125
bacteriological requirements for, A8
sugar-phosphate esters of, A110
system of payment for, A32
tank-truck assembly of, A150
tocopherol content of, A127
treated with oxygen, A109
ultrasonic treatment of, A127
variations in ionic and lactose concentrations of, A127
vegetable, processing and nutritive value of, A43
vitamin B_{12} activity of, A83
watered, problem of, A108
Milk albumin, new method for obtaining, A6
Milk bottle carrying device, A104
Milk bottle crate, A45
Milk can filling attachment, continuous, A74
Milk can, future of, A47
Milk can hoist, A124
Milk can rack, A124
Milk cans, single service, dispenser for, A153
Milk collection, bulk, A152
Milk constituents, propionate as precursor of, A26
Milk containers, paper, future supplies of, A47
Milk control, State, A11, A12
Milk cooler, A17, A18
portable, A138
spray-type expansible, A107
surface, heat transfer in, A22
Milk coolers, surface, efficiencies of, A138
Milk diet,
and malaria, A39
deficient in iron, copper and manganese, effects of, A127
Milk delivery systems, continuous, pressure equalizing device for, A107
Milk dispenser, inanimate cow, A72
Milk distribution, and pricing in Great Britain, A48
Milk ejection curves, automatic recording apparatus for, A38
Milk evaporated, stability during sterilization of, A89
Milk fat adulteration, A70
Milk fat blending apparatus, A11
Milk fat,
from acetate and glucose, biosynthesis of, A109
melting and solidification of, A21
unsaturated acids in, A103
Milk fats, whole, component acids of, A118

Milk fever, and milking methods, A65
Milk filling system, continuous, A45
Milk fortification, continuous, with vitamins, method for, A127
Milk handling,
bulk, A138
analyses of, A51
bulk vs. can, A152
can and tank, cost analysis of, A17
Milk handling system, bulk, bacteriological studies of, A82
Milk line flushing system, A138
Milk lines, conventional, cleaned-in-place, A53
Milk market, school, A121
Milk measuring device, A11
Milk minerals, related to minerals in pasture herbage, A22
Milk plant,
cooperatives, students learn in, A32
specifications and costs for, A47
Milk plants, economic analysis of, A13
Milk powder,
cultured, manufacture of, A67
determination of fat and water in, A103
influence of lipids on dispersion of, A133
preparation of, A30
Milk preparations, saffron and nutmeg in, A82
Milk pricing, formulas for, A38
Milk producers, expectations and plans of, A71
Milk product, high protein, A116
Milk production,
as related to treatments in previous lactation, A49
effect of glucose injections on, A110
effect of tannins on, A137
in Ohio, shifts in, A136
in the United States, 1924-51, A21
influence of liveweight on, A73
inheritance vs. environment in, A49
persistency, effect of various pastures on, A15
pressed vs. extracted linseed cakes for, A49
relation between grazing behavior, forage digestibility and intake and, A48
relative value of feeds for, A72
timing for highest profit, A86
Milk products,
cold, separator for, A45
frozen concentrated, A43
method and apparatus for thermal treatment of, A52
vitamin enrichment of, A23
Milk protein food product, A30
Milk proteins,
biosynthesis of, A39
concentrated, A5
effect of heat on, A43
enzymic iodination of, A68
nutritive value of, A89
sensitiveness of, A117
Milk quality,
as affected by farm practices, A107
improved by ultracentrifugation, A8
Milk release apparatus, A86
Milk releaser, diaphragm, A107
Milk sales, with bulk flow dispensers, A32
Milk sampling, method and apparatus for, A52
Milk secretion, in intervals between milkings, rate of, A89
Milk separation, cold, A126
Milk solids,
determination of, A83
oxidimetric measurement of, A147
dry, tailor made, A67
not-fat, rapid determination of, A147
nonfat dry, protein reducing value of milk as indication of presence of, A9
reconstituted, effect on maturational progress of children, A23
Milk souring, effect of menadione on rate of, A52, A108
Milk strainer, A18, A36
Milk substitute, A88
Milk tank cooler, A151
Milk tests, detergents and, A10
Milk utilization,
DISI's World Congress for, A85
World Congress for, A21
Milk waste, design of plants for disposal of, A53
Milk wastes, water-pollution-control program in relation to, A28
Milk yield,
effect of iodinated casein on, A89
effect of management systems on, A35
influence of tocopherol feeding on, A33
of ewes, effect of diet on, A16
Milk yield persistency, factors affecting, A22
Milker, suspended, A36
Milking and pulsation rate, A38
Milking barn, portable, A152
Milking machine, A87, A107
airtight, A50
Milking machine pulsator, A87
Milking machine timer, A151
Milking machines,
automatic valve assembly for, A139
control unit for, A74
signaling device for, A17
Milking methods, and milk fever, A65
Milking, once-daily, in late lactation, effects of, A138
Milking parlor, grade "A," A18
Milking parlor stall, A151
Milking rubbers, effect of farm treatment on, A35
Milking structure, A152
Milking system, A87
valved coupling for, A36
Milking systems,
flushing apparatus for, A107
pipeline, valve mechanism for flushing, A128
Milkings, consecutive, rate of milk secretion in intervals between, A89
Milks,
cultured and fermented, A43
determining density of, A116
Dutch, vitamins in, A83
herd, inhibiting acid production, substances in, A92
homogenized, half-and-half, testing procedure for, A70
yield and "recovery numbers" when made into cheese, A144
Milk shakes, machine-made, A75
Mineral constituents, of cow blood, A26
Mineral metabolism, of calves, A39
Minerals,
blood, as related to milk and milk fat yield, A25
for cattle, A123
intake and excretion at parturition, related to parturient paresis, A1
Mix, chocolate, A75
Mixes, low fat high solids, preparation of, A18
Mixing device, for liquids, A84

Mold,
butter print, A143
for home frozen confection, A124
on cheese, gas treatment for control of, A144
Mold inhibition, by sorbic acid, mechanism of, A57
Molybdenum, diseases of cattle in relation to, A2
Mouthpiece for cap magazines, A45
Multiple sclerosis, in relation to nutrition, A39
Multi-product plant, A93

NEBACETIN, secretion and effect in milk, A81
Neo-natal immunity, colostrum in relation to, A40
Nicotinic acid,
in human milk, A31
metabolic functions of, A140
Nipple, for calf feeding bucket, A74
Nisin, effect on anaerobic spore-formers from cheese, A146
Nitrogen,
fecal metabolic, determination of, A110
nonprotein, utilization by rumen organisms as affected by diet and antibiotics, A39
Nozzle, for multiflavor ice cream, A87
Nutmeg, in milk preparations, A82
Nutrition,
animal, antibiotics in, A141
carbohydrate, in bloating sickness, A29
of *B. melitensis*, A31
human, significance of vitamins in, A109
multiple sclerosis in relation to, A39
ruminant, A17
of ruminants, antibiotics in, A59
Nutritional assay, of protein in powdered whey, A93
Nutritional research, purified casein for, A140
Nutritional value,
of beet molasses, A49
of milk, selling consumers on, A23
Nutritive value,
of carob, A49
of colostrum, A25
of fat, A76
of milk, A89
of milk and milk products, A140
of milk, effect of heat on, A23
of milk, factors affecting, A154
of milk for rats, A23
of tobacco seed extraction salvage, A34
of vegetable milk, A43

OIL, edible, from gourds, A49
Oiler, stock, animal operated, A74
Oleomargarine cutting machine, A103
Opportunities, turning our problems into, A11
Orange peels, for cattle feeding, supplementation of nitrogen in, A16
Orchard grasses, isolation of hemicelluloses from, A102
Organoleptic testing, errors in, A80
Osmaron B, in milk, properties of, A101
Outer-market distribution, of milk in paper containers, A150
Outer-market sales, A94
Ova transfer, progesterone and relaxin as aids in, A90
Ovarian bursae, disease conditions in, A79
Oxidization, of cream, prevention of, A62
Oxidized flavor, in recombined frozen milks, prevention of, A125
Oxygen, treating milk with, A109
Oxygen uptake, in starters, A116
Oxytocin, effect on intramammary pressure, A76, A139

PACKAGE lab, Kraft's A93
Packaging, efficient, cuts ice cream marketing costs, A96
Paint,
mildew eliminated by new type of, A46
water, enzyme-digested protein for use in, A145
Paints,
dairy, application of, A46
latex, modified proteins for stabilization of, A80
Palletized loading, A47
Pantothenic acid, metabolic functions of, A140
Papain, crystallized, amino acids of, A118
Paper milk containers, future supplies of, A47
Parturient paresis, mineral metabolism related to, A1
Pasteurization,
of cream, behavior of phosphatase during, A126
no-hold, makes progress, A21
tests for, A22
Pasteurization, HTST,
dual operation of, A96
of ice cream mix, A18, A96
of milk,
creaming impairment in, A97
phosphatase inactivation in, A97
timing with homogenizers, A31
Pasteurizer, HTST,
alkaline cleaners for, A128
plate-type, mechanical features of, A97
Pasteurizer, steel cap, measurement of temperature in, A89
Pasteurizing equipment, in-place cleaning of, A77
Pasture,
pearl millet, value for cattle, A14
winter, as economical feed, A15
Pasture forage, digestibility of, A105
Pasture herbage minerals, related to minerals in milk, A22
Pastures, various, influence on persistency of milk production, A15
Patent developments, in cheese industry, 1900-51, A66
Pearl millet pasture, for cattle, value of, A14
Pectin, production from citrus peel, A19
Pens, portable, calves thrive in, A2
Phosphatase,
behavior during cream pasteurization, A126
milk,
HTST pasteurization inactivation of, A97
lipoprotein complex association of, A118
methods for determination of, A10
purification of, A118
reactivation of, A20, A153
serum, alkaline, activity in pure and crossbred cattle, A24
Phosphatase tests, various, examination of, A102
Phosphatases, of organs, A26
Phosphorus, in milk,
biochemistry of, A39
effect of mastitis on, A113
Phosphorus linkages, in α-casein, A147
Physiology,
environmental, of domestic animals, A24
of calcium metabolism, A24
Pipe bending, cuts costs, A32

Pipeline milker, vacuum regulating device for, A50
Pipeline milking, A35, A63
Pipeline milking system, valve mechanism for flushing, A128
Placenta, retained, experimental production and prevention of, A62
Plant design, steps in, A95
Plant inspection, A58
Plant sanitation, A129
Plasma volume, of cows, A26
Poison, for thornapple, A50
Potassium, effects of intravenous administration of, A24
Pregnancy, essentiality of corpus luteum of, A25
Preservatives, in milk, detection of, A82, A147
Preventive medicine, on the farm, A2
Process control, for ice cream, A75
Processes and equipment, new, A148
Producers, formulas for pricing milk to, A38
Production problems, some, A95, A96
Products, in sealed containers, apparatus and preservation method for, A136
Profit sharing, A104
Profits, A95, A120
Progesterone,
as aid in ova transfer, A90
chromatographic separation of, A119
Propionate, as precursor of milk constituents, A26
Protein,
breast milk content of, A10
correlation between butterfat and, A153
dietary, heat injury to, A23
enzyme-digested, use in water paint, A145
in powdered whey, nutritional assay of, A93
milk, food product, A30
Protein content, of concentrates, effect on secretion of low-fat milk, A137
Protein denaturation, in frozen milk, estimation of, A97
Protein solutions, concentrated, refractive index of, A102
Protein synthesis, by rumen microorganisms, A7
Protein threads, artificial, process for, A145
Protein value, microbiological determination of, A105
Proteins,
determination of disulfide groups in, A68
fat-membrane,
amino acid composition of, A9
electrophoretic patterns of A9
sedimentation diagrams of, A9
importance of swelling capacity of, A115
milk,
effect of heat on nutritive value of, A23
enzymic iodination of, A68
nutritive value of, A89
sensitiveness of, A117
milk serum, effect of heat on, A43
modified, for stabilizing latex paints, A80
whey, A44
in bread, A81
Protozoa, oligotrich, in rumen, cultivation and metabolism of, A116
Pseudomonas putrefaciens, hexokinase of, A31
Psychrophilic bacteria, effect on finished product, A30
Pulsation and milking rate, A38
Pulsator, A36, A87
Pump-and-pipe processing, profit through, A139
Pumping mechanism, A32
Pyruvic acid, in human milk, A31

Q-FEVER, and its relation to dairy products, A1
Quarts, sample with, A32
Quaternary ammonium compounds, quantitative colorimetric microdetermination of, A68
Quaternary ammonium germicides, testing, A31

RADIOIODINE, uptake by thyroids, effect of phenothiazine on, A111
Raisins, cottage cheese with, A42
Rancidity, of fat, mechanism of, A44
Rations,
dairy, whole cottonseed in, A73
for livestock in Britain, A13
low and high fat, for cows, trials with, A123
Refrigeration,
and insulation, reefer's function keyed to, A11
control means, A84
dry ice, necessary factors for, A11
Refrigeration system, for light truck, A45
Relaxin, as aid in ova transfer, A90
Rennin, crystalline, preparation of, A118, A135
Reproduction,
in mice, effect of margarine on, A23
in rabbits, effect of vitamin A deficiency on, A110
Reproductive efficiency, in cattle, factors affecting, A106
Restaurants, sell dairy chocolate to, A33
Retail stores, sanitation study of, A60
Retained placenta, experimental production and prevention of, A62
Riboflavin,
in milk, effect of light on, A126
metabolic functions of, A140
Roughage,
butterfat tests affected by supply of, A33
high quality, economic importance of, A106
Rubbers, milking, effect of farm treatment on, A35
Rumen,
bovine, magnitude of microbial fermentation in, A136
calf, lactobacilli from, A145
effect of ash content of ingesta on pH of, A111
sheep,
cultivation and metabolism of oligotrich protozoa from, A116
facultative anaerobic bacteria from, A67
fermentation of glycerol in, A48
unidentified factor stimulatory to cellulose digestion in, A13
viable counts of microflora of, A6
Rumen development, in calves, glycemic levels and, A39
Rumen microorganisms,
cellulose digestion by, A93
effect of diet and antibiotics on utilization of nonprotein nitrogen by, A39
Ruminant digestion, A25, A26
Ruminant nutrition, A17
Ruminants,
antibiotics in growth of, A17
antibiotics in nutrition of, A59
cellulose digestion by, A123
copper deficiency in, A25
Galega officinalis, a poisonous plant for, A26
utilization of dietary carbohydrates by, A16

SAFETY code, for mechanical refrigeration, A10
Saffron, in milk preparations, A82
Sales,
of butter, increasing, A41
outer-market, A94
trends that will influence, A36
Sales plan, for greater gallonage, A61
Salt, new, for cheese, A100
Salt block, all weather, A15
Salts, of calcium and potassium, effects on sperm motility, A26
Sanitation,
dairy plant, A98, A129
in retail outlets, A60
of milk pipelines on farms, effect of installation type and cleaning procedure on, A63
Sanitizing agents,
evaluation of, A98
iodophors as, A98
Sediment tester, double stage, A109
Sediment testing, of milk from bulk tanks, A88
Sediment testing apparatus, A22
Sedimentation diagrams, of fat membrane proteins, A9
Self-service stores, switch to, A125
Semen,
hyaluronidase activity in preservation of, A26
investigation of estrogens and testosterone in, A25
Semen diluents,
in artificial insemination, A85
osmotic pressure of, A86
Semen, diluted, survival and transmission of *Trichomonas foetus* in, A55
Semen diluter, milk as, A73
Separator, centrifugal,
for cold milk, A22
for cold milk products, A45
Septic tanks, treatment of dairy waste water in, A128
Sequestration, by sugar acids, A53
Serum calcium, ethylenediamine-tetra-acetate method for, A101
Sewage,
dairy, putrescibility and O-R potential in, A28
raw coliform and enterococci MPN in, A27
Shelter engineering, and environmental physiology, A141
Sherbet flavor ratings, A95
Sherbets,
citrus-flavored, A51
new advances in, A96
Silage,
grass, and Swiss cheese quality, A66
influence on milk properties, A14
new chemicals for, A49
use of whey paste and powder in, A14
Silage digestibility, effect of limestone on, A151
Silage quality, influence on cheese quality, A151
Six to twelve (promotions in selling), A51
"Soft-serve" business, how to build, A19
Solar activated flavor, of homogenized milk, A126
Sorbic acid,
as dietary component, harmlessness of, A57
cheese protecting effectiveness of, A57
in cheese,
resistance to oxidative deterioration, A57
spectrophotometric determination of, A57
mechanism of mold inhibition by, A57
metabolism of, A57
migration from wrapper into cheese, A57
Sorghum fodder, harvest of, A16
Specific gravity, of reconstituted skimmilk, temperature variation of, A133
Sperm,
effect of dried fodder and vitamin A on, A106
pseudo-molecular behavior of, A25
Spermatozoa,
effects of salts on motility of, A26
metabolism of acetylcholine in, A26
Spray-cleaning evaporators and vacuum pans, A112
Sprayer, livestock, A138
Stabilizing agents, A37
Stall,
metabolism, for steers, A111
milking parlor, A151
Starters,
flavor formation biochemistry of, A119
oxygen uptake in, A116
Stencils, for ice cream, individuality in, A61
Sterility, hereditary, female, in Holstein-Friesian cattle, A124
Sterilization,
hormonal, mechanism of, A39
radiation, of foods, developments in, A101
Stock waterer, A35
electric automatic, A36
Strainer, milk, A36
Streaked hairlessness, in Holstein-Friesian cattle, A59
Streptococci,
group N,
aroma-producing, from Cheddar cheese, A146
serological typing of, A7
used in cheese, inhibition and stimulation of lactic acid-producing properties of, A145
Streptococcus faecalis, and *E. coli*, in relation to sanitary quality of food, A133
Stress, starvation and thermal, effects on acid-base balance of cattle, A111
Stripping, after machine milking, relationship between mastitis and method of, A65
Students, learn in cooperatives milk plant, A32
Subdealer, A123
Sucaryl, in frozen desserts, use of, A61
Sugar acids, sequestration by, A53
Sugar liquid, A36
Sugar-phosphate esters, of milk, A110
Sulfhydryl groups, amperometric titration of, A68
Sulfur, and ergothioneine formation, A39
Sundaes, packaged, nozzle for, A19
Sunlight flavor, in milk, origin of, A37
Supermarket merchandising, a look at, A46
Supermarket survey, on fluid milk, A103
Supermarkets, trend to night openings by, A105

TANK, bulk, conversion to, A122
Tank-truck assembly, of milk, A150
Tannins, in lespedeza, effect on milk production, A137
TDN, as measure of feed energy, A14
Teat cup, A74
Teat cup inflations, testing device for, A151
Teat topography, method for reproduction of, A56
Teats, clogged, dilator for, A29
Teeth, of the ox, anatomy and physiology of, A131

Testing methods, on lactating cows, improving accuracy of, A86
Testosterone,
chromatographic separation of, A119
of semen, investigation of, A25
Themeda quadrivalvis, as cattle feed, A16
Thiamine, metabolic functions of, A140
Thickening agents, A37
Thornapple, herbicides against, A50
Thyroid uptake of radioiodine, effect of phenothiazine on, A111
Thyroprotein, for lactating ewes, effect on lamb weights, A111
L-thyroxine, effects upon cattle, A34
Time and motion studies, in ice cream plants, A87
Timer, milking machine, A151
Tin taste, in milk, chemicals against, A52
Tips for retailers, A94
Tocopherol,
in butter, as means of detecting adulteration with vegetable oils, A134
in cow's milk, A127
Tocopherol deficiency, experimental, in calves, A137
Tocopherol feeding, influence on milk and fat yield, A33
Tobacco seed extraction salvage, nutritive value of, A34
Trace elements, in milk, micro-determination of, A117
Trailer, why make two when one will do?, A46
Trend, to night openings by supermarkets, A105
Trends,
dairy industry,
annual study of, A60
Florida, A104
future, A47
in European dairy plant equipment, A44, A71
in ice cream costs, A37
Trichomonas foetus, in semen, survival and transmission of, A55
Trimethylamine, in fodders containing fish meal, A49
Trucks, converted to LPG, A46
Twin cattle,
description of variation in, A34
monozygotic, studies in, A49, A50
variation in fertility in, A35
Tympanometer, recording, for measurement of intramammary pressure, A139
Tyramine, Cheddar cheese flavor in relation to, A4
Tyrothricin, for calves, A73

UDDER,
effects of abnormal machine milking on histopathology of, A56
lactating, incorporation of C^{14} acetate into lactose by, A110
milk quantity and quality from different quarters of, A89
perfused, uptake of plasma amino acids by, A26
Ultrasonic treatment, of milk, A127
Ultraviolet irradiation, for removal of bacteria, use of, A101
Unions, company credit, A71
Urea nitrogen, value with different carbohydrate feeds, A13
Urine, cow, methods of studying, A39
Uterus, bactericidal activity of, A106

VACUUM tank, with pipeline milking, A35
Valve,
bottle filler, A103
release, pressure, for milk hose, A151
Valve-actuating mechanism, A148
Valve mechanism, for flushing pipeline milking systems, A128
Valve ring, centrifugally operable, for power washing cream separators, A88
Vanilla-like synthetic, cuts ice cream flavor cost, A60
Vapor barrier, A103
Vasopressin, effects on intramammary pressure, A139
Vegetable fat frozen dessert, Costella's volume of, A50
Vegetable milk, processing and nutritive value of, A43
Vegetable-oil frozen desserts, sales influencing trends, A36
Vending,
hits big time, A121
machine, of milk, experiences in, A121
outdoor, volume and profit in, A120
ups profits, A120
Vending machine, for ice cream cones, A87, A152
Vending machines,
an opportunity for new milk plants, A121
selling milk through, A120
Vending milk, through factory outlets, A95
Vending success, location the key to, A120
Vitamin A,
calf liver stores of, A23
deficiency, in rabbits, effect on reproduction, A110
effect on sperm quality, A106
estimation of depletion time in calves, A52
feed content of, A34
in butter, stability of, A154
in milk, effect of mastitis on, A113
in milk, throughout lactation, A69
metabolism in cattle and sheep, A23
placental and mammary transfer of, A39
relationship to hyperkeratosis in calves, A55
stability in feeds, effect of stabilized fats on, A59
Vitamin B_2, content of cheeses, A43
Vitamin B_6, metabolic functions of, A140
Vitamin B_{12} activity, of milk, A83
Vitamin B_{12} feed supplement, A72
Vitamin B_{12} in feeding animals, A34
Vitamin C,
antioxygenic action of, A6
in sheep milk as affected by *Helichrysum italicum*, A26
Vitamin D,
enrichment of milk with, A23
in fortified milk, control of, A23
in Indian butters, A132
Vitamin E, in food and fodder, determination of, A31
Vitamin concentrates,
in feeding cattle, use of, A34
method for continuous fortification of milk with, A127
Vitamin content, of legumes, A49
Vitamin enrichment, of sour milk products, A23
Vitamins,
in Dutch market milk, A83

in human nutrition, significance of, A109
lactic acid bacteria biosynthesis of, A101
Volatile acids, in cheese, paper chromatography of, A147

WASH facilities, modern, A77
Washing machine, for cases, cans, and crates, A128
Waste water, dairy,
from butter factories, A28
problem of, A128
treatment in septic tanks, A128
Wastes, phenolic, microbiological factors in treatment of, A101
Water evaporation, from body surface, measurement of, A110
Water-insoluble acids, in cream, rapid estimation of, A88
Water-insoluble fatty acids, in cream and butter, rapid estimation of, A119
Water metabolism, A141
Water-pollution-control program, in relation to dairy wastes, A28
Waterer, stock, A35
electric automatic, A36
Weaner, A74
Weaning halter, calf, A86
Whey,
in preparation of silage, use of, A14
powdered, nutritional assay of protein in, A93
proteins of, A44
substitutes for hen albumin from, A6
Whey constituents, titration curves of, A135
Whey products, process of manufacture, A5
Whey proteins, in bread, A81
Whey solids, quick testing of, A81
Whips, edible, A6
Wilting, carbohydrate breakdown during, A48

XANTHOPHYLLS, in alfalfa, A93

YUCCA leaves, as fodder, A48

JOURNAL
OF
DAIRY SCIENCE

VOLUME XXXVII
JANUARY—DECEMBER 1954

1954
THE AMERICAN DAIRY SCIENCE ASSOCIATION
THE OHIO STATE UNIVERSITY, COLUMBUS, OHIO

CONTENTS

JANUARY, NO. 1

Influence of Roughages on Certain Biochemical Properties of Milk. V. N. Krukovsky, G. W. Trimberger, K. L. Turk, J. K. Loosli, and C. R. Henderson 1

The Use of Anthrone for the Quantitative Estimation of Lactose in Dairy Products. H. J. Fagen, Elizabeth Sibbach, and R. V. Hussong 10

Management Practices and Net Returns in Milk Production in Washington. E. L. Baum, C. W. Mey, A. O. Shaw, and H. G. Waikup 14

Relationship Between Titratable Acidity and pH During Lactic Acid Fermentation in Reconstituted Nonfat Milk. H. H. Wilkowske 22

Blood Studies of Breeding Dairy Bulls. I. Hematocrit, Hemoglobin, Plasma Calcium, Plasma Inorganic Phosphorus, Alkaline Phosphatase Values, Erythrocyte Count, and Leucocyte Count. L. L. Rusoff, J. E. Johnston, and Cecil Branton 30

Bacteriological Studies on High-Temperature Short-Time Pasteurization of Ice Cream Mix. M. L. Speck, C. A. Grosche, H. L. Lucas, Jr., and L. Hankin 37

The Influence of Glycerol Level, Various Temperature Aspects and Certain Other Factors on the Survival of Bull Spermatozoa at Sub-Zero Temperatures. W. J. Miller and N. L. VanDemark 45

Sulfur Dioxide as a Preservative for High Moisture Legume Silage. L. Dufour, R. P. Niedermeier, C. E. Zehner, and J. W. Crowley 52

The Effect of the Ensiling Process on Wild Onion and Ragweed Flavors in Silage and in Milk. R. E. Brubaker and P. M. Reaves 58

Fat Separation in Evaporated Milk. I. Homogenization, Separation, and Viscosity Tests. R. B. Maxcy and H. H. Sommer 60

The Analysis of Errors in Assaying Fecal Androgens in the Dairy Cow. A. Grandage, R. B. Casady, and H. L. Lucas 72

Some Nutritional Requirements of Bovine Rumen Bacteria. J. J. McNeill, R. N. Doetsch, and J. C. Shaw 81

Degree of Herbage Selection by Grazing Cattle. W. A. Hardison, J. T. Reid, C. M. Martin, and P. G. Woolfolk 89

Information for Authors 103

People and Events 107

Letters to the Editor 111

Our Industry Today 113

Association Announcements 119

Officers and Committees of the Association 121

Membership Directory 125

Abstracts of Literature A1

FEBRUARY, NO. 2

Relationship Between Fat Globule Surface Area and Carotenoid and Vitamin A Content of Milk in Successive Portions of a Milking. R. F. White, H. D. Eaton, and Stuart Patton 147

A Method for the Detection of Foreign Fats in Dairy Products. V. R. Bhalerao and F. A. Kummerow 156

Studies of Herd Management Records. II. Relation of Gestation Length to Birth Weight of Holstein Calves of Both Sexes at Various Calvings. H. P. Davis, Mogens Plum, and Benjamin Brost 162

A Quantitative Appraisal of the Free Amino Acids in Foreign Type Cheese. F. V. Kosikowsky and A. C. Dahlberg 167

The Digestibility of Honeysuckle (Lonicera japonica) *for Yearling Dairy Bulls.* J. E. Noland and S. H. Morrison 173

Slime Formation on Cottage Cheese. P. A. DAVIS AND F. J. BABEL 176
A Detailed Study of Levels of Certain Blood Constituents in Normally Calving Dairy Cows and in Dairy Cows with Parturient Paresis. P. J. VAN SOEST AND T. H. BLOSSER 185
The Effect on Milk and Fat Production of Injections of Oxytocin at Alternate 14-day Periods During Lactation. D. G. SPRAIN, VEARL R. SMITH, W. J. TYLER, AND O. T. FOSGATE 195
A Modified Peroxide Test for Detection of Lipid Oxidation in Dairy Products. C. M. STINE, H. A. HARLAND, S. T. COULTER, AND R. JENNESS 202
Growth Characteristics of Streptococcal Phages in Relation to Cheese Manufacture. V. L. ZEHREN AND H. R. WHITEHEAD 209
Diluters for Bovine Semen. II. Effect of Milk Proteins upon Spermatozoan Livability. D. L. THACKER, R. J. FLIPSE, AND J. O. ALMQUIST 220
Metabolic Responses of Bovine Spermatozoa to Antibacterial Agents. CECIL BRANTON AND W. B. PRATHER 228
People and Events 235
Letters to the Editor 240
Our Industry Today:
Manufacture of Quality Cream Cheese. ERIK LUNDSTEDT 243
Appraising the Transmitting Ability of Sires Placed in Artificial Service as Young Bulls. C. S. RHODE 245
Abstracts of Literature A29

MARCH, NO. 3

The Effect on Milk Production of Legume Silage Harvested in the Bud Stage vs. Full Bloom Stage of Maturity of Alfalfa. V. S. LOGAN 247
Some Factors Affecting Age at Puberty in Holstein-Friesian Heifers. H. W. HAWK, W. J. TYLER, AND L. E. CASIDA 252
Antibiotics in Dairy Cattle Nutrition. III. Effects of Different Levels of Aureomycin Intake upon the Growth and Well-Being of Dairy Calves, and the Association of Differences with Changes in Environment. E. E. BARTLEY, F. W. ATKESON, H. C. FRYER, AND F. C. FOUNTAINE 259
Observations of Dairy Cow Activities in Loose-Housing. R. C. LEWIS AND J. D. JOHNSON .. 269
Effects of Vacuum Level and Milking Duration on Milk Production, Milking Time, and Rate of Milk Flow in Mastitis-Free First Calf Heifers. A. T. GREGOIRE, R. D. MOCHRIE, F. I. ELLIOTT, H. D. EATON, A. A. SPIELMAN, AND GEOFFREY BEALL 276
The Utilization of Molasses and Urea in the Rations of Growing Dairy Cattle. V. R. BOHMAN, G. W. TRIMBERGER, J. K. LOOSLI, AND K. L. TURK 284
Studies of Feeding Aldrin to Dairy Cows. R. E. ELY, L. A. MOORE, P. E. HUBANKS, R. H. CARTER, AND F. W. POOS 294
The Influence of Oxytocin-Induced Udder Evacuation on Milk and Butterfat Production in a Complete Lactation. J. D. DONKER, J. H. KOSHI, AND W. E. PETERSEN 299
Fat Separation in Evaporated Milk. II. Age-Thinning of Concentrated, Sterilized Milk. R. B. MAXCY AND H. H. SOMMER 306
Effect of Form of Alfalfa When Fed as the Sole Source of Roughage to Guernsey Cows on the Carotenoid and Vitamin A Content of Milk. H. M. HANSEN, G. H. PORTER, R. E. JOHNSON, H. D. EATON, GEOFFREY BEALL, AND L. A. MOORE 311
The Destruction Rate of Psychrophilic Bacteria in Skimmilk. O. W. KAUFMANN AND R. H. ANDREWS 317
Fiber Digestion Using the Miniature Artificial Rumen. C. N. HUHTANEN, R. K. SAUNDERS, AND L. S. GALL 328
People and Events 336
Letters to the Editor 343
Our Industry Today:
Use of Demonstrations in Dairy Science Teaching. W. B. COMBS 345

Fly and Rodent Control in Dairy Processing Plants. T. L. HUGE 348
Guideposts for the Dairy Industry. P. M. BRANDT 352
Outer-Market Distribution of Milk in Paper Containers in the North Central Region. SHELDON WILLIAMS 353
Abstracts of Literature A41

APRIL, NO. 4

Assay of Cows' Urine for Pregnanediol. D. L. HILL, W. E. PETERSEN, AND S. H. COHEN 355
The Influence of Dietary Calcium and Phosphorus on the Incidence of Milk Fever in Dairy Cattle. J. M. BODA AND H. H. COLE 360
Use of Special Processed Soybean Flour and Whey Solubles in Milk Replacement Formulas for Dairy Calves. J. F. STEIN, C. B. KNODT, AND E. B. ROSS 373
The Unsaturated Fatty Acids of Milk Fat. I. Methyl Ester Fractionation and Isolation of Monoethenoid Constituents. L. M. SMITH AND E. L. JACK 380
The Unsaturated Fatty Acids of Milk Fat. II. Conjugated and Nonconjugated Constituents. L. M. SMITH AND E. L. JACK 390
The Unsaturated Fatty Acids of Milk Fat. III. Geometrical Isomerism. L. M. SMITH, N. K. FREEMAN, AND E. L. JACK 399
The Antibacterial Action of Penicillin, Streptomycin, and Sulfanilamide Against Heavy Suspensions of Vibrio fetus *Added to Semen Extender.* A. EUGENIA ORTHEY AND H. L. GILMAN 407
The Antibacterial Action of Penicillin and Streptomycin Against Vibrio fetus *Including Concentrations Found in Naturally Infected Semen.* A. EUGENIA ORTHEY AND H. L. GILMAN 416
Metabolism of Bovine Semen. I. Uptake of Glucose-C^{14} by Bovine Spermatozoa. R. J. FLIPSE 425
Butyrated Lard in the ad Libitum Feeding of "Filled Milk" for Veal Production. JOHN H. HOPPER, K. E. GARDNER, AND B. CONNOR JOHNSON 431
The Microflora of Blue Cheese Slime. C. B. HARTLEY AND J. J. JEZESKI 436
The Mechanism of Sunlight Flavor Formation in Milk with Special Reference to Methionine and Riboflavin. STUART PATTON 446
The Effect of Fat-Free Diets on Young Dairy Calves with Observations on Metabolic Fecal Fat and Digestion Coefficients for Lard and Hydrogenated Coconut Oil. H. M. CUNNINGHAM AND J. K. LOOSLI 453
Association Announcements 462
People and Events 463
Letters to the Editor 466
Our Industry Today:
Use of Nutrition Information in Promoting the Use of Milk Products. ZOE E. ANDERSON 467
The Role of the Dairy Industry in Utilizing Our Inexhaustible Resources. J. P. LAMASTER 472
The Manufacture of Low Heat Nonfat Milk Solids. S. T. COULTER, ROBERT JENNESS, AND HERBERT HARLAND 476
Abstracts of Literature A55

MAY, NO. 5

Measurement of Butyric Acid in Fat with Reference to the Detection of Substitute Fats in Dairy Products. W. J. HARPER AND T. V. ARMSTRONG 481
Parenteral Administration of Aureomycin to Young Calves with a Note on Mode of Action. L. L. RUSOFF, J. M. FUSSELL, C. E. HYDE, R. M. CROWN, AND L. S. GALL 488
Apyrase Activity of the Mammary Gland. E. M. CRAINE AND R. G. HANSEN 498
Phosphokinase Activity of the Mammary Gland. E. M. CRAINE AND R. G. HANSEN 505

A High Roughage System for Raising Calves Based on Early Rumen Development. IV. Synthesis of Thiamine and Riboflavin in the Rumen as Influenced by the Ratio of Hay to Grain Fed and Initiation of Dry Feed Consumption. H. R. CONRAD AND J. W. HIBBS 512
Lactation Response to Artificially-Dehydrated and Pelleted Alfalfa Added to a Ration of Timothy-Grass Mixed Hay and Grain. F. S. WARREN, R. E. JOHNSON, CECILIA M. DEMBICZAK, H. D. EATON, GEOFFREY BEALL, AND L. A. MOORE 523
Aspartate Dissimilation Reactions of Rumen Bacteria. F. M. SIROTNAK, R. N. DOETSCH, ROSLYN Q. ROBINSON, AND J. C. SHAW 531
A Comparative Study of Human, Cow, Sow, and Rat Milk Using Paper Chromatography. H. R. ROBERTS, J. D. PETTINATI, AND WESLEY BUCEK 538
A Comparison of Some Cellular and Chemical Constituents of Blood at Time of Parturition and after Administration of Adrenocorticotrophin. W. G. MERRILL AND VEARL R. SMITH 546
A Simple Test of Quality in Hay. EMMETT BENNETT AND J. G. ARCHIBALD 552
New Advances in the Electroejaculation of the Bull. WILLIAM G. R. MARDEN 556
Outdoor Individual Portable Pens Compared with Conventional Housing for Raising Dairy Calves. L. R. DAVIS, K. M. AUTREY, H. HERLICH, AND G. E. HAWKINS, JR. 562
The Effect of Cation and Anion Resin Mixtures on the Salt Content of Raw Skimmilk. G. K. MURTHY AND R. MCL. WHITNEY 571
Studies on the Use of Permanent Milk Pipelines in Dairy Barns. III. Labor (Time) Requirements for Operation of Pipeline and Conventional Installations in a Stanchion Barn. W. O. NELSON, E. E. ORMISTON, AND M. H. ALEXANDER 583
Report of Committee on Butter 590
Program—Forty-Ninth Annual Meeting of the American Dairy Science Association 593
People and Events 616
Letters to the Editor 621
Our Industry Today:
The Fortification of Whole Milk and Skimmilk. L. A. MAYNARD 624
The Self-Help Program. MACK GEBERT 628
A Filtration Method for Roller Process Dry Buttermilk Solids. D. R. STROBEL AND C. J. BABCOCK 631
Abstracts of Literature A65

JUNE, NO. 6

Abstracts of Papers Presented at the Forty-Ninth Annual Meeting 633
Studies on Aureomycin and Vitamin B_{12} Supplementations for Dairy Cows. II. Effect on Production, Composition, and Vitamin B_{12} Content of the Milk. L. L. RUSOFF AND M. O. HAQ 677
A Comparison of the Ability of Certain Egg Yolk Diluents to Maintain Optimum Osmotic Conditions During the Storage of Bull Semen. J. T. SMITH, D. T. MAYER, AND H. A. HERMAN 684
Fertilization Rates and Embryonic Death Rates in Cows Bred to Bulls of Different Levels of Fertility. H. E. KIDDER, W. G. BLACK, J. N. WILTBANK, L. C. ULBERG, AND L. E. CASIDA 691
Factors Affecting the Sensitivity and Accuracy of the Phosphatase Test. G. P. SANDERS, O. S. SAGER, AND J. A. HUPFER 698
The Use of White Mutants of Penicillium roqueforti *in Cheese Making.* H. A. MORRIS, J. J. JEZESKI, AND W. B. COMBS 711
Free Fatty Acid Content of Fresh Milk as Related to Portions of Milk Drawn. W. R. THOMAS, W. J. HARPER, AND I. A. GOULD 717
A High Roughage System for Raising Calves Based on the Early Development of Rumen Function. V. Some Effects of Feeding Aureomycin with Different Ratios of Hay to Grain. J. W. HIBBS, H. R. CONRAD, AND W. D. POUNDEN 724

In Vivo (Dairy Calves) and in Vitro Studies with Surface-Active Agents. H. H. VOELKER, R. S. ALLEN, N. L. JACOBSON, AND J. T. BLAKE 737
A Selection Index for Fat Production in Dairy Cattle Utilizing the Fat Yields of the Cow and Her Close Relatives. J. E. LEGATES AND J. L. LUSH 744
Antioxidative Properties of Cacao and Their Effect on Butteroil. W. S. MUELLER 754
Standardized Procedures for the Babcock Test for Milk. A Committee Report 761
Proposed Public Relations Objectives of the American Dairy Science Association. A Committee Report 769
People and Events 772
Abstracts of Literature A79

JULY, NO. 7

Lipase: A Review. B. L. HERRINGTON 775
Amino Acids and Peptides in the Protein-Free Fraction of Milk before and after Incubation with Streptococcus lactis. W. C. VAN DER ZANT AND F. E. NELSON 790
Characteristics of Some Endocellular Peptidases of Streptococcus lactis. W. C. VAN DER ZANT AND F. E. NELSON 795
A Study of Hemoglobin Levels in the Blood of Young Dairy Calves and the Alleviation of Anemia by Iron. J. W. THOMAS, M. OKAMOTO, W. C. JACOBSON, AND L. A. MOORE 805
Studies on Sulfur to Nitrogen Ratios in Feeds for Dairy Cows. R. F. DAVIS, CONSTANCE WILLIAMS, AND J. K. LOOSLI 813
Inhibition of the Oxidized Flavor of Milk with Chelating Compounds. L. R. ARRINGTON AND W. A. KRIENKE 819
Effects of Formaldehyde and Copper Salts on the Heat Stability of Evaporated Milk. VICTOR NELSON 825
The Effect of Lactose Crystallization on Protein Stability in Frozen Concentrated Milk. L. TUMERMAN, H. FRAM, AND K. W. CORNELY 830
Action of Aerosols of Certain Viricidal Agents on Lactic Streptococcus Bacteriophage. F. W. BENNETT AND F. E. NELSON 840
Action of Certain Viricidal Agents on Lactic Streptococcus Bacteriophage in Liquids. F. W. BENNETT AND F. E. NELSON 847
Effect of Two Levels of Intake of a Vitamin A Depletion Ration on Some Blood Constituents and Deficiency Criteria in the Dairy Calf. J. E. ROUSSEAU, JR., C. F. HELMBOLDT, CECILIA M. DEMBICZAK, E. L. JUNGHERR, H. D. EATON, AND GEOFFREY BEALL 857
A Wettability Method for Powdered Milk. U. S. ASHWORTH AND HANS GUNTHARDT 863
Methods of Determining the Per Cent Total Solids in Milk by Means of the Lactometer. B. HEINEMANN, J. COSIMINI, E. L. JACK, J. J. WILLINGHAM, AND B. M. ZAKARIASEN 869
Effects on Economy and Efficiency of Milk Production when Thyroprotein Is Fed for a Short Period of Time to Milking Cows. J. W. THOMAS, D. V. COPLAND, E. A. KEYES, A. G. VAN HORN, AND L. A. MOORE 877
Relative Value of Carotene from Alfalfa and Vitamin A from a Dry Carrier Fed at Minimum Levels to Holstein Calves. J. E. ROUSSEAU, JR., H. D. EATON, C. F. HELMBOLDT, E. L. JUNGHERR, S. A. ROBRISH, GEOFFREY BEALL, AND L. A. MOORE 889
People and Events 900
Letters to the Editor 904
Our Industry Today:
Making the Farm Feed the Herd for Greater Production and Higher Profit, PAUL MONTAVON 905
The Wisconsin Cheese Exchange. R. W. LEFFLER 909
Dairy Research to the Rescue. EZRA T. BENSON 912
Abstracts of Literature A91

AUGUST, NO. 8

Cell Counts of Platform Samples of Herd Milk. PATRICIA MACLEOD, E. O. ANDERSON, AND W. N. PLASTRIDGE 919
Histochemical Studies of Fat Metabolism in Mammary Glands of Lactating Cows. B. C. HATZIOLOS, M. L. YAMIN-SMITH, AND J. C. SHAW 924
Experiments with Ion-Selective Membranes. I. The Electrolytic Deionization of Protein-Free Whey. W. H. WINGERD AND R. J. BLOCK 932
Influence of Fertility Level and Treatment of Semen on Nonreturn Decline from 29 to 180 Days Following Artificial Service. R. E. ERB AND F. H. FLERCHINGER 938
Influence of Treatment and Fertility Level of Semen on Distribution and Nonreturn Decline of Repeat Service Intervals. F. H. FLERCHINGER AND R. E. ERB 949
The Nutritive Value of Corn Silage for Milking Cows. C. F. HUFFMAN AND C. W. DUNCAN 957
Parturient Paresis. VII. A Study of the Leucocytes of Cows with Parturient Paresis. VEARL R. SMITH AND W. G. MERRILL 967
The Yield and Protein Content of Silage Corn as Influenced by Fertilization. K. E. HARSHBARGER, W. B. NEVENS, R. W. TOUCHBERRY, A. L. LANG, AND G. H. DUNGAN 976
Antibiotics in Dairy Cattle Nutrition. IV. Comparative Effects of Different Levels of Crystalline Aureomycin and a Crude Aureomycin Fermentation Product (Aurofac 2A) on the Growth and Well-Being of Young Dairy Calves. E. E. BARTLEY, F. C. FOUNTAINE, F. W. ATKESON, AND H. C. FRYER 982
Proceedings of the Forty-Ninth Annual Meeting of the American Dairy Science Association. P. R. ELLSWORTH, Secretary-Treasurer 990
People and Events 1014
Our Industry Today:
Automatization of Dairy Processing Operations. DALE A. SEIBERLING 1019
Evaluation of Collegiate Student Dairy Products Judging Since World War II. P. A. DOWNS, E. O. ANDERSON, C. J. BABCOCK, F. H. HERZER, AND G. M. TROUT 1021
Abstracts of Literature A99

SEPTEMBER, NO. 9

Biological Activity of Phosphate Esters in Mammary Gland Extracts. E. M. CRAINE AND R. G. HANSEN 1027
The Technique of Electroejaculation and Its Use in Dairy Bulls. P. J. DZIUK, E. F. GRAHAM, AND W. E. PETERSEN 1035
Conception Rates in Dairy Cattle from Services at Various Intervals after Parturition. GEORGE W. TRIMBERGER 1042
Laboratory Tests, Singly and in Combination, for Evaluating Fertility of Semen and of Bulls. P. J. BUCKNER, E. L. WILLETT, AND NED BAYLEY 1050
Fat Separation in Evaporated Milk. III. Gravity Separation and Heat Stability. R. B. MAXCY AND H. H. SOMMER 1061
Prenatal Mortality in the Bovine Between Pregnancy Diagnosis at 34-50 Days Post-Insemination and Parturition. O. T. FOSGATE AND VEARL R. SMITH 1071
Histology of the Pituitary, Testis, and Adrenal in Relation to Reproduction in the Bull. P. T. CUPPS, R. C. LABEN, AND S. W. MEAD 1074
The Ear and Leaf-Stalk Contents of Corn Forage as Factors in Silage Evaluation. W. B. NEVENS, K. E. HARSHBARGER, R. W. TOUCHBERRY, AND G. H. DUNGAN 1088
Interference by Glycerol with Differential Staining of Bull Spermatozoa as Used with Semen Thawed from the Frozen State. J. P. MIXNER AND JACK SAROFF 1094
Lactose Crystallization in Ice Cream. I. Control of Crystal Size by Seeding. T. A. NICKERSON 1099
Recent Progress in the Manufacture and Use of Lactose: A Review. S. M. WEISBERG 1106
The Feeding Value of U. S. No. 1 Alfalfa Hay and U. S. No. 2 Alfalfa Heavy Timothy Mixed Hay. C. H. GORDON, L. A. MOORE, AND W. H. HOSTERMAN 1116

Effect of Dehydrated Young Grass as a Supplement in Dry Lot Feeding on the Reproductive Efficiency of Dairy Bulls. R. J. FLIPSE AND J. O. ALMQUIST 1123
Bacteriological Studies of Cultured Buttermilk. II. Progressive Changes in the Numbers of Leuconostoc citrovorum *and* Streptococcus cremoris *as Associated with pH and Acetylmethylcarbinol Plus Biacetyl Levels.* W. E. GLENN AND C. C. PROUTY 1128
People and Events 1134
Letters to the Editor 1138
Our Industry Today:
Brucellosis Is Being Wiped Out. C. G. BRADT 1141
Abstracts of Literature A113

OCTOBER, NO. 10

Reproductive Rates and Growth of Purebred Brown Swiss Cattle in Brazil. G. G. CARNEIRO AND J. L. LUSH 1145
A Study of 1,000 Bovine Genitalia. J. R. PERKINS, DURWARD OLDS, AND D. M. SEATH 1158
The Effect of Storage Temperatures on the Growth of Psychrophilic Organisms in Sterile and Laboratory Pasteurized Skimmilks. W. C. LAWTON AND F. E. NELSON 1164
The Effect of Relaxin upon Milk Ejection. I. The Let-Down Effect upon Sheep. D. D. SHAFFHAUSEN, R. M. JORDAN, AND A. E. DRACY 1173
A Study of Actively Cellulolytic Rod-Shaped Bacteria of the Bovine Rumen. M. P. BRYANT AND R. N. DOETSCH 1176
Assay of Various Mold-Ripened Cheeses for Antibiotic Activity. H. H. WILKOWSKE AND W. A. KRIENKE 1184
B-Vitamin Levels in the Blood of Young Dairy Calves Fed a Milk Replacement Diet with and without Aureomycin. Q. T. SMITH AND R. S. ALLEN 1190
Methods-Time Measurement Analysis of Some Milk Plant Cleaning Operations. G. P. MARLEY, W. M. ROBERTS, AND R. W. LLEWELLYN 1198
Diluters for Bovine Semen. III. Effect of Lactenin and of Lactoperoxidase upon Spermatozoan Livability. R. J. FLIPSE, STUART PATTON, AND J. O. ALMQUIST 1205
The Effect upon Milk Production and Body Weight of Varying Withdrawal Periods after Thyroactive Supplement Feeding. E. W. SWANSON 1212
The Ulnar Epiphyseal Cartilage Width in Normal and Rachitic Calves and Its Use Compared to Other Methods of Detecting Rickets. J. W. THOMAS, M. OKAMOTO, AND L. A. MOORE 1220
The Thyroxine Content of Thyroactive Iodinated Proteins as Determined by a Radioactive Isotope Dilution Technique. E. P. REINEKE 1227
The Effects of Varied Rates of Hay Feeding on Body Weight and Production of Lactating Dairy Cows. T. G. MARTIN, G. E. STODDARD, AND R. S. ALLEN 1233
Some Factors Affecting the Action of Benzoyl Peroxide in the Bleaching of Milk and Cream for Blue Cheese Manufacture. S. KURAMOTO AND J. J. JEZESKI 1241
People and Events 1247
Our Industry Today:
Trends in Packaging of Food. MARIAN G. KLEIN 1251
The Influence of Dairymen's Knowledge on Their Success and Actions. C. V. HESS AND L. F. MILLER 1255
Abstracts of Literature A131

NOVEMBER, NO. 11

The Effects of Hourly Milking with the Aid of Intravenous Injections of Oxytocin. J. D. DONKER, J. H. KOSHI, AND W. E. PETERSEN 1261
The Effect of Feeding Soybeans on Blood Plasma Carotene and Vitamin A of Dairy Calves. M. F. ELLMORE AND J. C. SHAW 1269

Age at First Calving Used with Milk Yield During First Lactation to Predict Lifetime Production of Indian Cattle. D. Sundaresan, F. E. Eldridge, and F. W. Atkeson.... 1273
Further Observations on the Composition of Grass Silage. J. G. Archibald and J. W. Kuzmeski.... 1283
Thermal Death Time Studies of Brucella abortus *in Milk.* F. R. Kronenwett, S. A. Lear, and H. J. Metzger.... 1291
Diluters for Bovine Semen. IV. Fertility of Bovine Spermatozoa in Heated Homogenized Milk and Skimmilk. J. O. Almquist, R. J. Flipse, and D. L. Thacker.... 1303
Diluters for Bovine Semen. V. A Comparison of Heated Milk and Egg Yolk–Citrate as Diluters for Semen from Bulls of High and Low Fertility. J. O. Almquist.... 1308
Identity and Origin of the Malty Aroma Substance from Milk Cultures of Streptococcus lactis *var.* maltigenes. H. W. Jackson and M. E. Morgan.... 1316
Microbiological and Chemical Studies of Sweet Potato Vine Silage. H. H. Hall, J. L. Etchells, I. D. Jones, and W. M. Lewis.... 1325
The Effect of Various Factors on the Vitamin D Content of Several Common Forages. H. A. Keener.... 1337
Factors Responsible for the Development of a Hay-Like Flavor in Vitamin A Fortified Low-Fat Milk. K. G. Weckel and Etzer Chicoye.... 1346
The Relationship Between Fertility and the Number of Spermatozoa Inseminated. R. W. Bratton, R. H. Foote, and C. R. Henderson.... 1353
Effects of Various Diets on the Diurnal Patterns of Blood Plasma Lipides of Dairy Calves. H. A. Ramsey, G. H. Wise, S. B. Tove, and R. K. Waugh.... 1357
Inheritance of Black Hair Patterns in Cattle Lacking the Extension Factor for Black (E). I. Blackish. C. S. Baldwin, L. O. Gilmore, and N. S. Fechheimer.... 1368
Relationship Between Plasma Vitamin A and Liver Vitamin A in Calves Fed a Vitamin A Depletion Ration and Calves Fed Minimum Levels of Vitamin A or Carotene. J. E. Rousseau, Jr., Cecilia M. Dembiczak, K. L. Dolge, H. D. Eaton, Geoffrey Beall, and L. A. Moore.... 1376
People and Events.... 1383
Our Industry Today:
Developments and Trends in Dairy Farm Building Design and Construction. Thayer Cleaver.... 1392
Trends and Challenges in the Training of Dairy Technologists. H. A. Bendixen.... 1397
The Public Looks at Milk Sanitation. J. C. Flake.... 1399
Abstracts of Literature.... A143

DECEMBER, NO. 12

A Quantitative Spectrographic Method for the Determination of Tin, Copper, Iron, and Lead in Milk and Milk Products. The Effect of Storage on the Concentration of These Metals in Evaporated Milk. C. W. Gehrke, C. V. Runyon, and E. E. Pickett.. 1401
An Ion-Exchange Resin-Contact Time Method for the Study of Inorganic Equilibria in Milk. J. M. Baker, C. W. Gehrke, and H. E. Affsprung.... 1409
Frozen Homogenized Milk. IX. Freezing Characteristics of Homogenized and Unhomogenized Milk. C. J. Babcock, D. R. Strobel, Lt. Col. R. H. Yager, and E. S. Windham.... 1416
Body Weights, Body Measurements, and Surface Area of Jersey and Sindhi-Jersey (F_1) Crossbred Females. R. E. McDowell, Douglas H. K. Lee, H. W. McMullan, M. H. Fohrman, and W. W. Swett.... 1420
A Comparison of Fertility of Bovine Spermatozoa Stored at 5° C. and −79° C. H. O. Dunn, H. D. Hafs, P. J. Buckner, G. F. Young, E. O. Conrad, E. L. Willett, and G. L. Larson.... 1429
The Relationship Between Forage Dry Matter Digestibility and Weight Gain by Dairy Heifers on Three Winter Grazing Crops. M. E. McCullough, D. M. Baird, and O. E. Sell.... 1435

Semen Production and Fertility of Dairy Bulls Ejaculated Either Once or Twice at Intervals of Either Four or Eight Days. R. W. Bratton and R. H. Foote 1439
Semen Production and Fertility of Mature Dairy Bulls Ejaculated Either Once or Twice at 8-Day Intervals. R. W. Bratton, R. H. Foote, and C. R. Henderson 1444
The Release of Ammonia Nitrogen from Urea, Ammoniated Molasses, and Soybean Oil Meal in the presence of Rumen Microorganisms. O. T. Stallcup 1449
Excretion of Dieldrin in the Milk of Cows Fed Dieldrin-Sprayed Forage and Technical Dieldrin. Ray E. Ely, L. A. Moore, R. H. Carter, P. E. Hubanks, and F. W. Poos .. 1461
In Vitro Studies of the Effect of Aureomycin and Terramycin on Mixed Suspensions of Bovine Rumen Bacteria. P. Jurtshuk, Jr., R. N. Doetsch, J. J. McNeill, and J. C. Shaw 1466
Technical Notes 1473
People and Events 1475
Letters to the Editor 1482
Our Industry Today:
Laboratory Training Program of the Robert A. Taft Sanitary Engineering Center in Milk and Food Sanitation. Robert P. Myers 1483
The Bulk Milk Handling and Pipe Line Milking on the Farm. H. E. Calbert 1485
Call for Papers for Annual Meeting 1489
Author Index of Original Articles 1490
Subject Index of Original Articles 1500
Author Index of Abstracts A157
Subject Index of Abstracts A176

"HANSEN'S"
DAIRY PREPARATIONS
For High Quality Dairy Products

- ☐ CHEESE RENNET AND COLOR
- ☐ COTTAGE CHEESE COAGULATOR
- ☐ ANNATTO BUTTER COLOR
- ☐ DANDELION BUTTER COLOR
- ☐ CERTIFIED BUTTER COLOR
- ☐ STARTER DISTILLATE
- ☐ ICE CREAM COLOR
- ☐ LACTIC FERMENT CULTURE
- ☐ CULTURE FLASKS
- ☐ CULTURE CABINETS
- ☐ TESTING SOLUTIONS
- ☐ ODORLESS TYPE DAIRY FLY SPRAY

Reliable Service Since 1878

Check and Mail for Literature

CHR. HANSEN'S LABORATORY, INC.
MILWAUKEE 14, WIS.

GBI
Reg. U.S. Pat. Off.

Creamy Smooth
FULL BODIED
ICE-CREAMS
Are Made with

TRADE BODY-GUARD MARK

The STABILIZER that Guards Your Quality

WRITE
for Folder No. 207 describing this Top Value in Stabilizers. Ask about our Special Trial Offer.

GENERAL BIOCHEMICALS, INC.
20 LABORATORY PARK • CHAGRIN FALLS, OHIO

A LITTLE BODY-GUARD GOES A LONG WAY

Now Available . . .

a limited supply of the new

DECENNIAL INDEX
of the JOURNAL OF DAIRY SCIENCE

Covering Volumes XXI-XXX. All Copies Clothbound.

COST: Members, $6.50 Non-Members, $7.50

Send check or money order to the

AMERICAN DAIRY SCIENCE ASSOCIATION
Ohio State University Columbus 10, Ohio

Your advertisement is being read in every State and in 45 Foreign Countries

Mention

Journal of Dairy Science

When Answering Advertisements

THIS HELPS BOTH THE ADVERTISER AND YOU

key laboratory servants

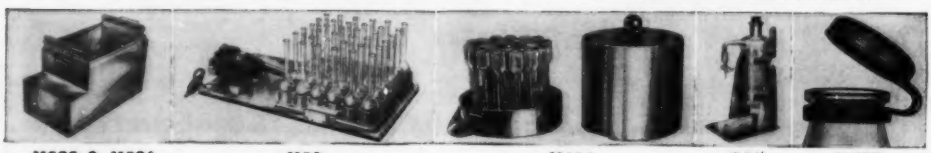
. . . that save and $$$$$

Write today for Bulletin 312 containing latest information on Mojonnier quality equipment and supplies for the modern dairy laboratory. Write:

MOJONNIER BROS. CO., 4601 W. OHIO ST., CHICAGO 44, ILL.

a flip of the thumb and it's open!

Mojonnier Composite Sample Bottles. Widely used in Dairy Industry for holding composite samples. Stopper cannot be dropped or lost — fits tightly, prevents evaporation. 3 sizes: G-400 — 4 oz. (¼ pt.) 7 day Tests. G-800 — 8 oz. (½ pt.) 15 day Tests. G-1600 — 16 oz. (1 pt.) 30 day Tests. All with etch spots.



M535 & M536 M50 M601 G46 M427

M535 & M536 Mojonnier Stainless Steel Babcock Test Bottle Bath. Thermostatically Controlled. Provides a means for keeping the fat in neck of babcock test bottles at proper temperature when readings are taken. Capacities 24 and 36—6" babcock bottles.

G46 Mojonnier Acid Bottle Trunnion. Stainless Steel. By tipping the bottle forward and then letting it come to an upright position, the pipette will fill to an exact pre-determined level.

M50 Mojonnier Babcock Bottle Shaker. Insures accurate fat reading. Complete with motor. Capacity 36 bottles. Size 11"x20".

M601 Wilson Babcock Bottle Washer. Designed to wash cream and milk test bottles, 6" or 9" size. Also used for washing test and culture tubes. Furnished in 24 and 36 bottle capacity. All stainless steel construction.

M427 One-Piece Rubber Closure with Connector. Recommended for use with bulk milk pickup tankers.

Mojonnier LABORATORY EQUIPMENT and SUPPLIES

Your advertisement is being read in every State and in 45 Foreign Countries

Guaranteed Results Lower Costs, with

UNIFORMITY IS IMPORTANT!

Leading agricultural schools and colleges agree that the regular weekly use of FLAV-O-LAC FLAKES assures uniformity of smoothness, aroma and flavor in fermented milk products.

YOGHURT CULTURE

FLAV-O-LAC FLAKES (shown) produce a quart of the finest starter on a single propagation. Single bottles $2.00.

New Cheddar Cheese Culture
Flav-O-Lac Flakes S. durans
$2.00 (plus postage)

THE DAIRY LABORATORIES
A DIVISION OF DALARE ASSOCIATES
23rd & Locust Sts., Phila. 3, Pa.
BRANCHES
New York Baltimore Washington
See our catalog in Dairy Industries Catalog

REVOLUTIONARY NEW CLEANING METHOD FOR HIGH TEMPERATURE EQUIPMENT

Chelation

AND WHAT IT MEANS IN SAVINGS

KLENZADE

O-R SYSTEM OF CLEANING

Again Klenzade leads with a remarkable new cleaning chemistry advance — Chelation. Initial cleaning with Klenzade O-R Organic Acid Cleaner is followed with Klenzade O-R Alkaline Cleaner. This produces an amazing series of chemical reactions — each one superpowered for a variety of specific cleaning actions never even approached before. "Chelation" prevents precipitation of water-borne minerals and assures film-free surfaces. Let us demonstrate to you that this revolutionary chemical cleaning advance — the Klenzade O-R System — will definitely save you hundreds of dollars annually.

Write for Details

ORGANIC ACID CLEANER • Single Cycle Cleaning • ALKALINE CLEANER

KLENZADE PRODUCTS, INC.
BELOIT, WISCONSIN
Branch Offices and Warehouses in Principal Cities

Reg. U.S. GBI Pat. Off.

'FRIGIDRY'
TRADE MARK
DAIRY CULTURES

Save Time—Save Money — Avoid Trouble. Use rapid-growing 'Frigidry' cultures to produce mother culture in one generation and take guess work out of making good buttermilk, butter and cheese.

LYOPHILIZED* for UNIFORMITY • VIABILITY • STABILITY

*New high-vacuum, sub-zero drying process.

FREE—*Write for Booklet No. 206 on production of Cultured Dairy Products.*

GENERAL BIOCHEMICALS, Inc.
20 LABORATORY PARK • CHAGRIN FALLS, OHIO

Copies of the

20-YEAR INDEX

covering Volumes I to XX, inclusive are available at the following prices:

★ ★ ★

MEMBERS		NON-MEMBERS	
Cloth Bound	$2.35	Cloth Bound	$5.50
Paper Bound	2.00	Paper Bound	5.00

Your advertisement is being read in every State and in 45 Foreign Countries

DIFCO

Media for

MYCOLOGY

DIAGNOSTIC

. . . for the isolation, identification and cultivation of pathogenic fungi. These media are also widely used in phytopathological studies. Several are neutral in reaction, giving optimum conditions for growth of a variety of fungi. The following may be prepared as selective media by the adjustment of reaction, addition of antibiotics or other agents:

Bacto-Brain Heart Infusion Agar
Bacto-Sabouraud Dextrose Agar
Bacto-Sabouraud Maltose Agar
Bacto-Littman Oxgall Agar
Bacto-Mycological Agar
Bacto-Mycological Broth
Bacto-Corn Meal Agar
Bacto-Corn Meal Agar with Dextrose
Bacto-Bean Pod Agar
Bacto-Prune Agar
Bacto-Lima Bean Agar

CONTROL

. . . for sanitary and sterility procedures as well as for general use in mycological procedures:

Bacto-Sabouraud Maltose Broth
Bacto-Sabouraud Liquid Medium
Bacto-Malt Extract
Bacto-Malt Agar
Bacto-Neurospora Culture Agar
Bacto-Potato Dextrose Agar
Bacto-Mildew Test Medium
Bacto-W.L. Nutrient Medium
Bacto-W.L. Differential Medium

CLASSIFICATION

. . . and nutritional studies of fungi:

Bacto-Yeast Morphology Agar
Bacto-Yeast Carbon Base
Bacto-Yeast Nitrogen Base
Bacto-Czapek Dox Broth
Bacto-Czapek Solution Agar
Bacto-Vitamin Free Yeast Base

THE DIFCO MANUAL, *NINTH EDITION*,
including descriptions of these media and their use,
is available on request.

DIFCO LABORATORIES
DETROIT 1, MICHIGAN